THE AGRIFLAG™ MULTI-TIERED TILAPIA AQUACULTURE CERTIFICATION SYSTEM

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Abstract

In a world with burgeoning populations, increasingly tight economic climates and growing concern over food security, aquaculture has been flagged as a potential key role player. However, smaller scale farmers and those in developing regions of the world often grapple with poor production output amid high personal capital investment and extremely high running costs. Pressure is on farmers to meet global standards of sustainable aquaculture practices, and viable production targets, yet in reality, most battle to make ends meet and produce a monthly profit, and cannot understand why. Significant correlation has been shown locally in South African cultured tilapia between subclinical fish health and fish growth, and this certification model was developed in an endeavour to address this identified problem by proactively assessing fish health, educating farmers, improving regional biosecurity, and offering them achievable and measurable standards to evaluate themselves and steadily improve their system and production health, in a step-wise and affordable manner.

How It All Started

The South African (S.A.) Tilapia aquaculture sector is a relatively young industry of 5-6 years, and, because of geographical, climatic, and permitting constraints, is dominated by recirculating aquaculture systems (RAS) within the provinces of Gauteng, Northwest Province and Limpopo.

Systems vary in size between 10 000 to 750 000 litres, and are dominated by Nile tilapia, *Oreochromis niloticus,* farmed under strict permitting restrictions, and to a lesser degree, our indigenous Mozambique tilapia, *Oreochromis mossambicus,* and the red-breast tilapia, *Tilapia rendalli.*

As systems became steadily established, farmers, under the banner of the Tilapia Aquaculture Association of South Africa (TAASA), recognized that pathogens were a potentially significant enemy, and there was need to assess if any pathogens were currently impacting the industry and posing a biosecurity risk. Thus, my MSc project: "A Health assessment of Tilapia (*Oreochromis* spp.) aquaculture systems in the northern provinces of South Africa" was born.

Because of budget limitations and poor diagnostic capacity in our region, the initial much focused planned assessment looking for specific pathogens of economic concern, was modified to a broader more holistic look at each farm. A representative sample group from each of 19 farms within our key- producing regions, was assessed clinically, morphometrically, necropsied, and a comprehensive microscopic and histopathological examination done. Targeted bacterial cultures were run based on histopathological suspicion. A comprehensive water analysis was also carried out, and each farmer completed a questionnaire on farm husbandry practices and biosecurity. Information from all datasets was analysed and correlations drawn between variables.

What We Weren't Expecting...

The devastating impact of disease and pathogens upon aquaculture production systems is well-documented. What is also well understood is the fine balance that exists between host resilience, environmental stress, and impact of pathogens.

What we didn't expect to find, however, was the sub-clinical impact of stressors and disease, where fish appeared clinically healthy, but, in fact were heavily impacted by pathogens and environmental stressors, causing compromised sub-clinical health and perhaps, most importantly, very poor growth.

A healthy South African farmed tilapia?? No

84.5% of fish assessed within our study looked healthy….

Amid:

- **Prolonged grow-out time** (71% farms showed fish growth below 70% of projected levels)
- **Ongoing chronic mortalities** of unknown cause (>90 % farms)
- **Poor sex-reversal management** (only 42.1% male only populations)
- **Poor water quality**: low dissolved oxygen (63% farms), low temperatures (47% farms), high carbon- dioxide (>58% farms), high nitrites (63.2% farms)
- **Abnormally high ecto-parasites** (17% farms)
- **Secondary bacterial disease** of concern (31.9% farms) with 21.4% farms positive for extremely pathogenic bacteria
- **High prevalence of hepatic, gastric and gill pathology**
- **Poor biosecurity practices** and **uncontrolled fish movement**
- **Stressed fish**

And perhaps most significantly, farmers were unaware of underlying problems, and that they had tools at their disposal to mitigate these and improve production. In a farm production system, where profit margins are extremely low because of high production costs (heating and feed), and working with a low-value commodity, reduced time on farm becomes a massive leverage tool between a financially viable model or not.

It was based on these findings, that the certification model was conceptualised.

Globally, health and biosecurity certification is understood to act as a valuable tool in maintaining both high standards of practice, as well as improving final marketability of the product. However, practical, and financial constraints to implementing such schemes in developing countries often prove prohibitive.

The farm health assessment identified critical areas of need within our industry:

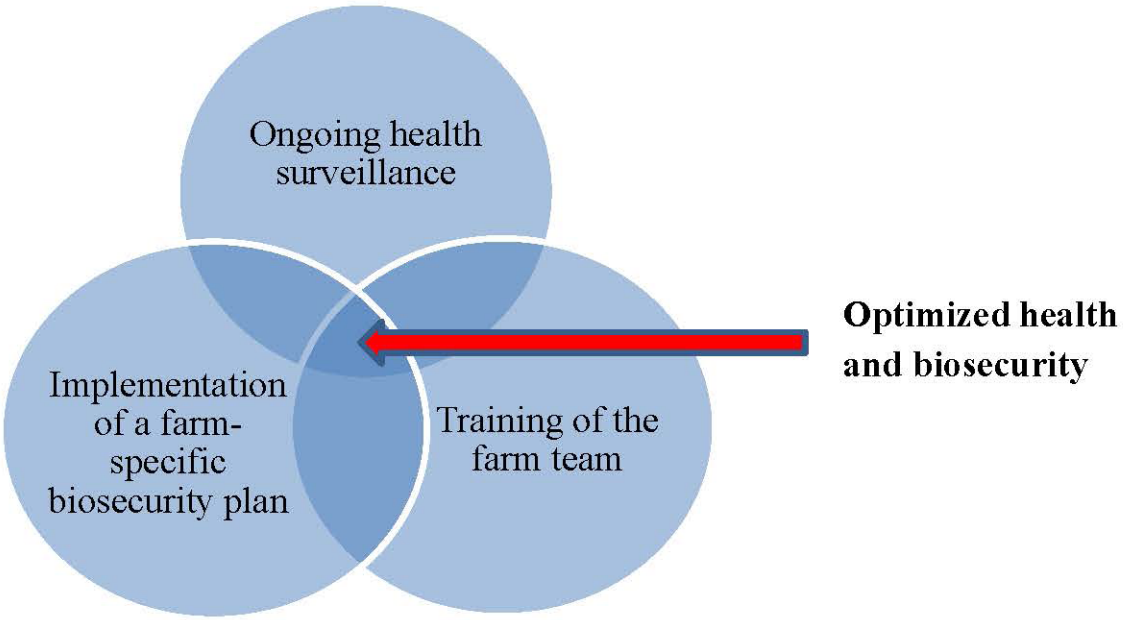
1. Sub-clinical disease is a significant hidden threat to production
2. There is value in identifying the underlying triggers
3. Farmers need support and mentoring

4. Any assistance needs to be provided in a cost- effective manner without further financially burdening farmers

In recognition of these needs, a three-tiered flagging system was designed as a pro-active national industry –specific health management strategy to address both improved biosecurity (the implementation of methods to prevent, eradicate or control the transmission of infectious diseases within an aquaculture operation) as well as fish health and welfare, in a practical economically viable manner. In such a way, all farmers from small-scale to large commercial enterprises can address fundamentals and build thereon, within their existing capacity. The model was designed by Dr Gillian Taylor, African Aquatic Veterinary Services, and has been adopted by TAASA as the South African tilapia aquaculture standard.

How It Works

The health plan has a three- tiered approach, focusing on three areas of need: design and implementation of a farm-specific biosecurity plan, routine health assessment, and education of the farm team. This serves to create a tight network to manage and improve fish health and identify underlying management and husbandry practices that continue to predispose to stressed unhealthy fish and systems.



The health plan encompasses:

1. A comprehensive biosecurity assessment of the epi-unit: An assessment of current farm- level biosecurity inclusive of a contingency plan in the event of a disease outbreak/ large scale mortality event, full risk analysis, identification of critical points and key diseases of concern for the unit.
2. An evaluation of the current level of farm knowledge on fish and system health and biosecurity, and identification of specific farm requirements.
3. Routine system and fish health parameters inclusive of a detailed water analysis, fish morphometrics, external pathology, necropsy data, parasite assessment, and histopathological assessment. This includes assessment of hatcheries, grow-out facilities, and brood-stock, as well as assessment and

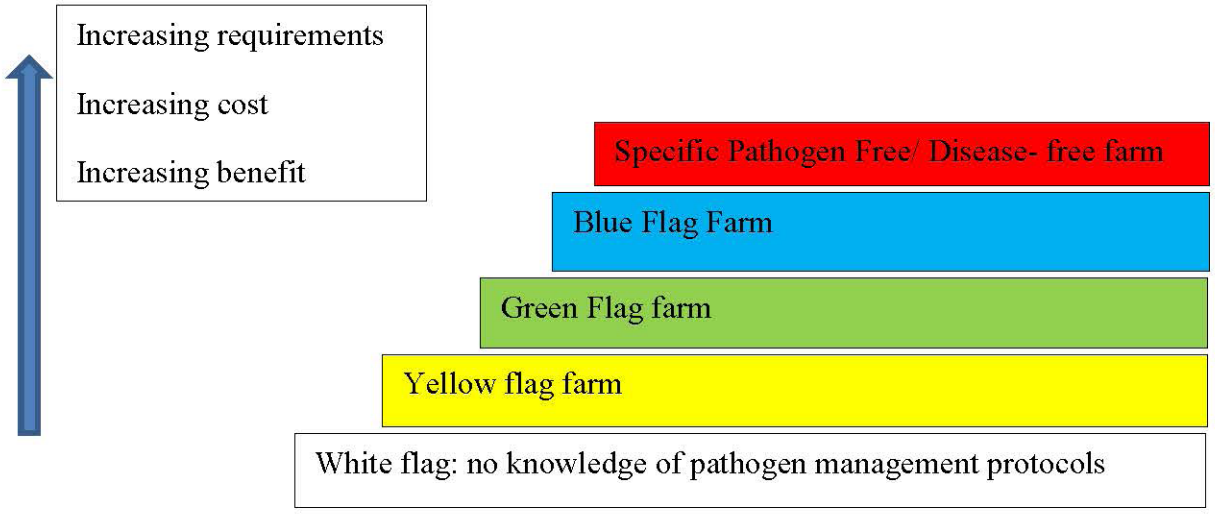
veterinary management of any large-scale mortality event. Laboratory screening for key tilapia pathogens of concern, inclusive of emerging diseases is included.

These three focal areas are addressed for each farm at the level that fits the farm and farmer.

Three "flag" certification levels are available for the certification process that address all three of the above focal areas, but scale them to suit the capacity of the farm. The farmers chooses what is practical and affordable to match his capacity and pocket. Even the lowest flag certification model carries significant potential impact upon each farming unit, and the farmer can upgrade to the next level as able. The focus is to support and encourage productivity and growth of the farm, not to add an additional financial burden. The assessment criteria consider the need for higher- level surveillance of hatcheries focusing on fry and fingerling distribution, as well as higher risk associated with open and semi-open aquaculture systems (through-flow systems, cages, net-pens etc.). As such, distribution hatcheries can only apply for blue-flag certification. Open/ semi-open aquaculture systems require green or blue flag certification, with compliance to specific assessment criteria. Annual certificates issued will specify the type of aquaculture system assessed.

Potential value added to each farm, lies in the multi-layered assessment of each system, where perhaps the most important factors impacting health like poor water quality and poor management practices can be timeously identified and corrected.

The tiered approach:



Requirements for each flagged tier are divided into a simple 4-step process:

1. Adherence to a list of tier-specific biosecurity criteria
2. Veterinarian input
3. Training and skills development
4. Disease/ health surveillance

The model has been designed to assess biosecurity comprehensively in terms of the seven focal areas of fish movement, access control, water management (both input and effluent), vector management, equipment management, quarantine, and health management. These are addressed with increasing levels of detail and farmer input through the ascending flag scale. However, even yellow flag level carries minimum quarantine adherence requirements, as well

as focus on fish movement and fish health monitoring- to ensure primary focal areas of concern are not neglected, but attended to in a simple and practical manner. By emphasizing these at the lowest tier, farmers are encouraged in the practice of self-monitoring and are more equipped to understand the "normal and abnormal" within their unique system. Higher flag levels carry more rigorous requirements within all focal areas, inclusive of compulsory mass- mortality investigations and assessment of quarantined groups, as well as regionally- based screening of water for food-safety pathogens and contaminants.

The model leans towards RAS systems, with their lowered environmental risk and better biosecurity application, however, can be applied to open or semi-open systems, with compliance to listed requirements.

Farmers are supplied with a tier-specific list of criteria to comply with. Onus rests upon them to meet the biosecurity requirements, which are subject to an annual inspection and certification by a TAASA- approved veterinarian. Several supporting standardized documents are in the process of being compiled to address specifics like acceptable disinfection protocols, management of effluent system water, humane euthanasia of morbidities, disposal of mortalities, correct storage and usage of feed etc. to facilitate farm implementation.

Diseases assessed are compiled as a fluid document annually, with focus on those diseases most likely to carry regional economic impact, those within regional diagnostic capacity and inclusive of serious emerging or controlled disease. Histopathology remains the mainstay of diagnostics because of its versatility and cost effectiveness. Costly higher- end diagnostics like bacterial cultures are included as a targeted diagnostic tool only. i.e. samples are collected but cultures are only performed pending high suspicion and/or prevalence on histopathology. Molecular tests currently are pending inclusion once capacity has been established in S.A. Again, to limit costs, pooling of samples for molecular tests is applied. The scope of disease surveillance remains constant through all flag levels in terms of sample numbers and diagnostic approach. However, frequency of farm inspections increases though the flags from annual (yellow flag) to quarterly (blue flag), with higher flag levels inclusive of higher-end diagnostics, and a broader farm overview. Production groups assessed on each tier vary according to flag level and whether the farm is operating simply as a hatchery or grow-out facility, or both. Sample times are coordinated to include seasons at highest risk for disease.

Data collected over time will prove invaluable in epidemiological assessment within regions and play a key role in how disease surveillance and diagnostics are established going forward. Sampling and health assessment of fish is carried out by TAASA- approved veterinarians only who meet acceptable aquatic skill standards.

Farmers are encouraged to keep average water parameters within target tolerance ranges, again, with focus on improved monitoring, health, and production rather than as a penalising tool. They are expected to monitor and record key water parameters at least weekly, and these rolling averages are considered within the certification criteria. With such high evidence of poor water quality and its dramatic influence on fish and system health, this was included as a core requirement. Simply put, no farm can be productive if water quality is poor. Training of farmers is envisaged to proceed with farm groups, to facilitate lower costs to farmers, use of TAASA- approved online resources, and structured to meet both the required levels of expertise and be applicable for the farm flag level. Attention will need to be given to literacy levels in existence and work within those challenges. Farm staff will be subject to an annual

assessment of sorts- again, with focus on identifying gaps needing attention, not penalizing farms.

Training will offer both opportunity for staff and farmers to optimize knowledge-application within their current circumstances, as well as grow in knowledge and ability to take on greater responsibilities. Emphasis will still be largely on farmer and farm manager because a sound head needs to lead an organization well. I foresee that this will be something that grows and enlarges with time. Currently, there is great need for understanding of basics like water quality monitoring, biosecurity practices, good record -keeping etc, but this will probably be an area that needs to expand as the industry knowledge base grows beyond foundational stage, and move more towards discussion and problem-solving as farms mature.

Benefits to Farmers

Aside from the obvious of improving farm health and productivity, there are multiple positive spin-offs inclusive of:

Peace of mind. Improved biosecurity. Lowered production costs. Lowered risk of disease introduction. Identifying underlying compromising factors. Improved food safety. Skills development and mentoring. Lowered environmental impact. Improved retail leverage. Facilitation of a support network. Reduced feed wastage. Optimized veterinary intervention. Improved farm team communication. Farm trends and patterns identified.

Benefits to Industry

Although focus of this biosecurity certification remains primarily supportive of improving productivity of emerging and commercial farmers and developing local trade, disease-free certification, export status and eligibility for the larger-scale international certification models becomes progressively more attainable through its implementation. Fish health and production levels have potential to be maintained at more efficient levels that would optimize economic returns to the farmer, as well as avoid disease and husbandry-related large-scale mortality events. In addition, the potential "clean-health" status that appears to exist within the local aquatic populations can be protected.

The industry and region in turn are better facilitated for:

- Improved disease risk analyses and focused strategic frameworks
- Improved farm planning
- Phased industry expansion
- Improved government awareness and streamlined collaboration with industry
- Improved viability of protection policies for industry
- More focused regional disease priorities
- Improved welfare of aquatic species
- Improved regional aquatic diagnostic capacity
- Raised industry standards of acceptable farm practice
- Reduced environmental impact

Additional key benefits include reduced use of drugs and antibiotics, improved fish welfare standards, improved food safety to consumer, improved social and environmental sustainability, and development of a database with respect to tilapia fish and system health in Southern Africa. This strategy would assist in developing a framework to facilitate development of responsible aquaculture while, together with improved food safety, meeting of health standards would facilitate eco-labelling and marketability and promote consumer and farmer confidence.

Will It Work?

Time will be the true evaluator. After initial release to the TAASA farmer members in

May 2020, the model is now in the process of being rolled out to key industry and government stakeholders for support. Despite adding cost to an existing financially strained industry, interest from the S.A. tilapia aquaculture sector has been good and immediate. It has been interesting to see that those farms signing up all want blue-flag status and understand the benefits of the higher tier. It has been encouraging to see that farmers see the benefit of the model. Those farms leading the way effectively trial the model and will highlight its effectiveness and gaps.

Success of this certification model will depend on shared responsibility and input from all levels: farmer, government, veterinary, industry and laboratories, as well as keeping the model fluid and continually amending and modifying according to what works and makes sense at the end of the day. It will always rest on cost vs benefit to farmer. Incentives to those farmers on a higher tier levels may be a wise addition because of the value they are potentially adding to industry.

Potential value is high. Scaling the model in the tiered format allows the smaller farmers to meet achievable goals and slowly move up the ladder as their production unit grows in size and profitability. Improving farm health status effectively improves industry and regional health status and biosecurity. Environmental impact is lowered. Product marketability is significantly expanded. Data sets collected will provide valuable epidemiological statistics. Diagnostic laboratories will be better informed on realistic regional diagnostic demand. And government will be better equipped to offer targeted assistance to industry.

Conclusion

Without doubt, there is great need for affordable input into better health management.

With developing regions like sub-Saharan Africa unable to afford high end international certification models, and widespread evidence of sub-clinical disease, and poor husbandry and biosecurity practices, there is great need for a model that addresses these problems in an affordable and practical way.

This model allows for a tight network to develop between farmer- veterinarian and industry, to continually support one another as the industry grows, and allows for recognition of small proactive steps. Creation of a tiered industry standard approach facilitates multiple outcomes inclusive of improved farming practices, incentives and motivation to strive for the best possible attainable goals, steady growth, a mentoring approach where the farmer is supported as he or she and the farm grows, improved collaboration between farmers and veterinarians, facilitation of a significant database of regional information, and significant control of disease within an epi-unit, whether it be a farm or a country.

About the Author

I am an Aquatic Veterinarian based in South Africa. After 20 years in small animal practice, I discovered the world of "Aquatic Veterinary Medicine", and started up my journey with 6 weeks in the USA, doing the Cornell University AQUAVET 1 course, and electives at the Shedd Aquarium in Chicago, and Disney, Florida.

On my return to South Africa, I was fortunate enough to be offered a research MSc project, with the Faculty of Veterinary Science, University of Pretoria, assessing overall fish and farm health in the young tilapia aquaculture sector of South Africa. This immersed me in the world of aquaculture, where I have been privileged to pioneer a path as a veterinarian, assisting the new industry with identifying key production challenges,(trying to) provide health solutions, and working together with farmers.

This has been an immense privilege and learning curve. In addition, I have been given the opportunity to serve on staff and introduce aquaculture to undergraduate veterinary students at the Faculty of Veterinary Science, at the University of Pretoria. This again, has been a wonderful experience.

I have served on the World Aquatic Veterinary Medical Association (WAVMA) Exco as Director at large- Africa, as well as the Tilapia Aquaculture Association of South Africa (TAASA) Exco, for the last 4 years managing the animal health portfolio.

Aside from my involvement in aquaculture, I practice privately as an aquatic veterinarian in Johannesburg, treating Koi and other ornamentals, through my consulting service, African Aquatic Veterinary Services, and manage research zebrafish populations at the Tshwane University of Technology.

The world of aquatics continually challenges me and enriches my work as a veterinarian. Whether it's carrying out health examinations on farms, water testing, teaching students, or treating someone's special pet fish, I absolutely love my work! My passion and goals are very focused on supporting the farming community, who fight ongoing challenges on a daily basis, growing and supporting my country and region, addressing food security, feeding people, encouraging small businesses, teaching and growing minds, and helping heal and handling with respect- both fish and people.

Soy In Aquaculture Program

This technical paper was created through the USSEC Soy In Aquaculture (SIA) program and the USSEC Southeast Asian Regional Program. USSEC works with target audiences in Southeast Asia and globally to show the utility and benefits of using United States soybean products in aquaculture diets.

The SIA program replaces the Managed Aquaculture Marketing and Research Program (the AquaSoy Initiative, funded and supported by the United Soybean Board and American Soybean Association) which was designed to remove the barrier to soybean meal use in diets fed to aquaculture species.

The objective of the SIA is to optimize soy product use in aquaculture diets and to create a preference for U.S. soy products in particular, including but not limited to U.S. soybean meal, soybean oil, soybean lecithin, and "advanced soy proteins" such as fermented soy and soybean protein concentrate.

This paper follows the tradition of USSEC to provide useful technical materials to target audiences in the aquaculture industry.

For more information on soybean use in aquaculture and to view additional technical papers, please visit the Soy-In-Aquaculture website at www.soyaqua.org.

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