PROMOTING COMMUNITY BASED CLIMATE RESILIENCE IN THE FISHERIES SECTOR PROJECT

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CONSULTANCY TO ASSESS THE LOCAL AVAILABILITY OF FISH FEED AND PREPARE A STRATEGY AND ACTION PLAN FOR IMPROVING ACCESSIBILITY TO AFFORDABLE QUALITY FISH FEED

Situation Analysis Report

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Abbreviations and Acronyms

JM	Jamaica
MICAF	Ministry of Industry, Commerce, Agriculture and Fisheries
MAF	Ministry of Agriculture and Fisheries
NFA	National Fisheries Authority
EU	European Union
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
IR	Inception Report
JMD	Jamaica Dollar
USD	United States Dollar
WB	World Bank
TL	Team Leader
CFR	Conversion Feed Ratio

SUMMARY

Introduction

This Situation Analysis Report constitutes deliverable # 2 of the assignment "CONSULTANCY TO ASSESS THE LOCAL AVAILABILITY OF FISH FEED AND PREPARE A STRATEGY AND ACTION PLAN FOR IMPROVING ACCESSIBILITY TO AFFORDABLE QUALITY FISH FEED".

As widely known, the availability of quality feed at an affordable price is the key to a credible development of aquaculture in any country that wants to successfully undertake such an activity. In the current framework of international crisis, which projects uncertainties even in the near future, the sustainability of the aquaculture sector will therefore increasingly rest on the strength of its feed supply chains, both in terms of price and continuity.

In this context, the goal of building a strong national fish feed supply chain, possibly based on local feed mills, fed mainly by raw materials of national origin, with an eye to its environmental and climate sustainability, is therefore very well suited to current needs and even more to future ones.

The following analysis, through the collection of data relating to the production of farmed fish (both food and ornamental), the fish feed (domestic and imported) consumption, and the raw materials and by-products available locally, gives us a sufficiently clear picture of the current situation and its potential for future development.

Background

The aquaculture context

In FAO rankings, Jamaica figures as a major importer of fish, import that is necessary to meet one of the largest domestic demands in the Americas. FAO data for the year 2017 in fact return us for Jamaica this picture: 25.8 kg of fish consumed per capita, with 48,000 tons imported (for a counter-value of 117 million USD) and 17,000 tons locally fished (i.e. 79% of all fishery products in 2017 was imported). Cross-referencing this data with 2017 Jamaican GDP per capita (equal to 5,070 USD) and with tourist presences recorded in the same year (equal to 4.3 million tourists, according to the Jamaica Tourist Board), given the structure of FAO data (which does not distinguish the consumer), given as well that Jamaican fish trend consumption follows the growth trend in tourist presences, we have the reasonable suspicion that a good part of this consumption is rather related to tourism.

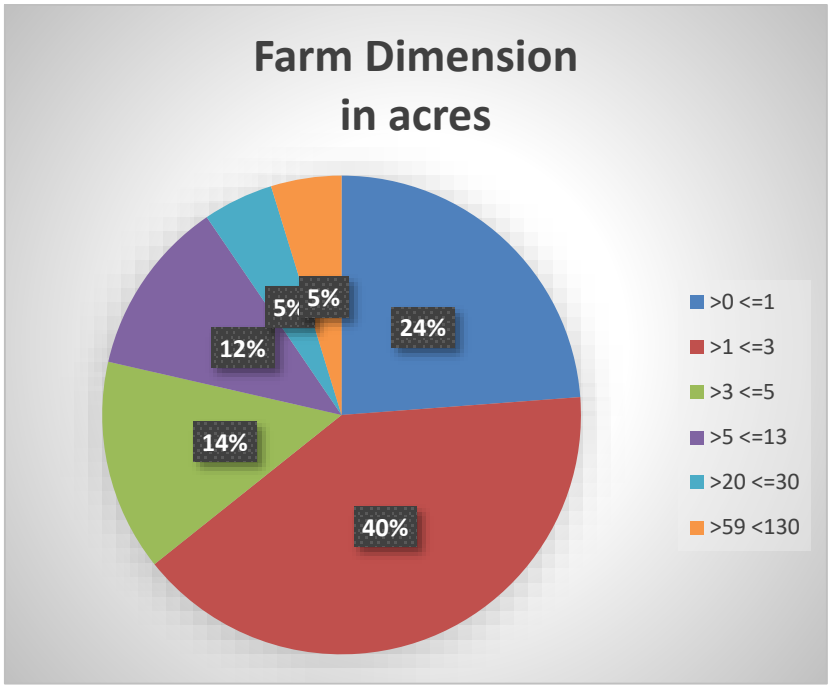
This would mean at least three things: first, that resident's consumption of fish is most likely lower than the official one and probably mainly oriented towards less valuable wild and farmed species; second, that most likely a relevant part of the imported fish is destined to the catering of hotel chains and in general to the restaurant sector, therefore constituted of more valuable species difficult to replace with the current local farmed fish; third, that the growth spaces related to both local consumption and tourist sector of both "less" and "more" valuable farmed species are very wide.

A brief and general description of the current Jamaican aquaculture

Tilapia farming

After a period of steady growth between the late '90s and early 2000s, which brought Jamaican aquaculture in 2006/7 to count 189 farmers and 1100 hectares of ponds capable of producing 8,019 tons of fish (almost solely Tilapia), since 2008 we are witnessing a sharp decline in aquaculture production. Decline that seems to have stabilized only in recent years.

In the last 5 years (2017/2021), Tilapia production is estimated at just over 1,000 tons per year on average[1], which is a decrease of approximately 87 percent compared to 2008 production.
As we already highlighted, factors that contributed to this major decline include high costs of energy, issues like availability/cost/quality of feed inputs, predial larceny, a low general interest with little support (both in research and investment) for the sector, competition of the Chinese imported frozen Tilapia. In addition to these already well-known factors, and after the just completed situation analysis phase, we can also add a certain lack of organisation and cooperation along the whole chain, from production to marketing, and the critical lack of farming contracts as used in the past.
In a preliminary quick survey of the current state of Jamaican aquaculture, we found that there are 84 farms still operational, of which only 69 had production in 2021.
Three out of four farms are located in the parish of St. Catherine. In this respect, in particular, almost 100% of the farms between 3 and 30 acres are located in this parish, while "only" half of the micro farms (0-1 acre) and the larger farms (>60 acres) are located here, the largest farm (125 acres) being located in the parish of St. Elizabeth. Most aquaculture occurs on the south coast of the island, mainly (83%) on its central plains (St. Catherine and Clarendon) where the farming conditions are the best.
Of the 84 farms surveyed, 66 are small sized (0-5) acres farms (78%), 10 are medium-sized (6-13 acres) farms (12%), 4 are medium-large sized (20-30 acres) farms (5%) and only 4 are large sized (over 60 acres) farms (5%).



All farms raise Tilapia; 77 (about 92%) are grow-out only, while only 7 carry out the complete cycle in-house (hatchery and grow-out), but the latter represent more than 50% of the acres in production and abt. 65% of the total fish produced. Tilapia farming in Jamaica is usually divided into 4 or more stages:

1. The breeding stage, which uses earthen ponds; stocking density is about 10,000 to 12,000 breeders per hectare; male/female ratios vary from 60/40 to 70/30 depending on the farmer; larvae are captured (daily or bi-daily) before they are 5 days old.

[1] Data from the Aquaculture Branch of the National Fishery Authority of the Ministry of Agriculture and Fisheries of the Government of Jamaica.

2. The masculinisation of larvae, which uses plastic tanks or concrete cisterns, where larvae remain for about 30 days and are fed a diet containing methyl-testosterone to produce male fry; the length of this period depends on the quality of the water and the type of feed.
3. The fry are then transferred to ponds, where they remain for about 60 days; the rearing density at this stage is up to 100,000 fry/ha and ponds are usually 1000 or 2000 m2 or are larger earthen ponds with hapas.
4. The final grow-out stage, carried out in earthen ponds with a depth of 0.80 to 1.20 cm, generally built on flat, clay soil and with year-round water availability (some areas such as Hill Run with a high concentration of livestock are served by the National Irrigation Commission, which is responsible for water distribution). This final phase usually lasts 180 days depending on the size of the fish required, feed and water quality. In recent years, even 60-90 days longer, due to feed availability and quality issues. Seeding densities of Tilapia fry vary from 1.5 to 7 fry per square metre; in the past up to 20 fry per square metre were used in intensive systems. Density varies according to various factors such as: the type of rearing (more or less intensive), the presence of aeration (almost not used due to high energy costs at this time), the possibility of strong water changes in the ponds, the availability of male fry on the markets, etc.
5. The final grow-out phase can be divided into two sub-phases, with a reduced stocking density in the final phase to improve growth rates. Fish sizes are selected at each stage. Many of the medium and small producers buy fry and only carry out extensive and semi-extensive grow-out in their ponds. Currently the selling weight ranges from 250 to 400 grams; for some Chinese customers up to 1.8 kg for special culinary preparations.

Mortalities along all the stages vary considerably, but are often high, ranging from a minimum of 20% up to 70%, due to the presence of predatory birds and crocodiles, not to mention the unfortunately still widespread predial larceny. Pathologies are not relevant also due to the low stocking densities. Nevertheless, green water technologies, which could greatly help in these very extensive farming conditions, are not used at all and almost completely unknown.

Available Aquaculture Branch[2] data from 2021 state only 8 fry producers, plus the Aquaculture Branch hatchery; few of these private producers sell to medium and small-scale farmers. The Aquaculture Branch hatchery supplies fry of 1 gr or advanced fry to many farmers. The scarcity and high cost of importing pre-starter, starter and crumble feed for hatcheries has created problems recently.

In a speech, the Minister of Agriculture and Fisheries, Hon. Floyd Green said that a new Aquaculture Branch hatchery will be built, through a financial contribution from World Bank, and will increase fingerling (advanced fry) production by 300 percent from a capacity of 1.5 million fries per year to five million fries per year when fully operational (May 13 – 2021, https://jis.gov.jm/aquaculture-facility-to-be-built-at-twickenham-park/).

The most common varieties of red Tilapia (the most popular species farmed in Jamaica) are the following: Stirling University Red, Red Jamaica, Taiwanese Red and Rocky Mountain White, according to surveys done by the team. Some farmers (Mr Bunting) and the Aquaculture Branch hatchery have

[2] The Aquaculture Branch, part of the National Fishery Authority, in addition to hatchery work, is involved in collecting field data on fish farm consistency and production, extension service to fish farmers, applied research and training by organising courses on Tilapia and ornamental fish farming.
There are also some farmer's organisations, such as the Jamaica Aquaculture Freshwater Association (JAFA), the Jamaica Ornamental Fish Farmers Association (with abt. 300 associates) and the Hill Run Fish Farmers Association, but they appear to be little active on both the organisational and training sides.

undertaken selection activities. At present, there are no studies on the purity of the varieties and it is not known if other varieties have been imported into Jamaica. Interviews with farmers report dark colourations in the red Tilapia varieties sold in the markets.

Farmed Tilapia is generally sold at the farm gate and most fish farmers rely on vendors (higglers) to buy and distribute their product. We also have the largest informal live fish market in Spanish Town and numerous small vendors along the major roads in the vicinity of the farms. Some farmers (DenCon, ex Algix) have set up shops for the direct sale and processing of live fish according to consumer needs (fillets, gutted, headless, whole, scaly, frozen whole scaly and gutted found in supermarkets). The farmer can also sell tilapia to restaurants, hotels, supermarkets and other distributors.

Finally, as for feeding, Hi-Pro Tilapia Super 10 (pellets with a minimum crude protein content of 28%), by Best Dressed Feed Mill, is the only type of Jamaican product available and used by almost all the farmers (other types of Hi-Pro Tilapia feed must be ordered in good time and were produced in small quantities in 2021), except for the largest farms that use up to 4 different types of imported fish feed and a farmer who self-produces his own feed.

Ornamental fish farming[3]

Ornamental fish production has a long history in Jamaica, starting in the 1970s when it was introduced by a USDA project. Since then, it has had periods of ups and downs, always linked to exports. In the 1990s, ornamental fish were exported for up to USD 190,000/year (Venema, 2004); the US market has always been the most receptive, both because of its proximity and the low prices of Jamaican product. In the years around 2010, prices became affordable again, but even then there was no follow-up with American customers; without structural, organisational and financial, support to achieve an economy of scale, Jamaica's ornamental aquaculture industry once again missed the mark.

Since 2017 the number of ornamental fish farms has been in steady decline, by moving from 75 farms in 2017 to 59 in 2022 (Aquaculture Branch data). Finally, the last two covid-19 years have definitely brought farmers to their knees, also forcing the major producer and only exporter, the Competitiveness Company[4], to close the business (it should also be borne in mind that Guardsman, the second largest producer, does not produce for profit).

In spite of this bleak Jamaican picture, the world market and the US market in particular saw an increase in demand for imported product at the same time of the covid-19 (probably driven by lockdowns, etc.), further blurring the gap between the great potential of Jamaican ornamental aquaculture and the vast opportunities of the export market.

[3] Data from:
-Field-work.
-Jamaica Business Development Center, JBDC - Business opportunity profile for ornamental fish production - Consultancy report, Kingston, Jamaica 2003.
-Rana, K., Stirling Aquaculture - Marketing plan for Jamaican ornamental fish industry - Consultancy report, University of Stirling, Scotland 2002.
-Agri-Business Division, ABD, Ministry of Agriculture - Marketing Plan for Tropical ornamental fish - Consultancy report, Kingston, Jamaica 1996.
-FAO - Plan for aquaculture development in Jamaica 2012 - 2025.
-Torreano, M.J., COMMIT - Ornamental fish cluster report - USAID supported study, Kingston, Jamaica, January 2007.

[4] The Competitiveness Company (TCC) was founded by a USDA project in 2007 and was conceived as a non-profit centre (affiliated to the Jamaica Exporters Association - JEA) for training, harvesting, packaging and exporting ornamental fish, with the main goal, as its name suggests, of improving Jamaican competitiveness on international markets. Production was to come from small local producers (300 were formed in recent years). Unfortunately, the productions of small farmers proved to be discontinuous over time, both in terms of quantity and quality. Despite a large customer base in the USA, the pandemic and, above all, the lack of constant production, have led the Company to close its operations at the end of 2021.

In fact, Jamaica, as is widely known, has both favourable climatic/environmental conditions and experience, coupled with technical capacity, in the production of tropical freshwater species, which account for most of the world trade.

To sum up: to date, there are about ten larger, full-time farmers, and about forty part-time backyards, the latter being present mainly in urban and peri-urban areas; world demand for ornamental fish is increasing[5], with Asian producers at a disadvantage both in transport costs, product quality and mortality; Jamaican farmers are producing quality ornamental fish, free of major diseases (particularly viral diseases) and transport to Miami is cheaper and fast.

Stakeholders are well aware of all this. They know that the opportunities are there and must be exploited with targeted and continuous investments and with ad hoc financial means. They only disregard, from our point of view, that without adequate organisation and cooperation between producers, these objectives are even more difficult to achieve; the farmers' association has no initiative and the cooperative spirit among farmers is rather absent.

Small farmers, who are the majority, do not use good farming practices and are not up to date on feeding, filtration/recycling, not to mention genetic, technologies to produce at their best. In addition, the bureaucratic procedures for exporting could be streamlined on an electronic platform as is being attempted throughout the aquaculture sector worldwide. Farmers also do not have good communication with the authorities and some do not want to register.

In order to export successfully and continuously to the US market, it is imperative to have consistency of supply, to deliver continuously with a short lead time, to have written standards (best practices), to comply with them, and to produce the large volumes required.

Currently, the Jamaican ornamental fish industry is not structured to meet any of the above points. In addition, US buyers demand: good prices and quality, i.e. consistency in fish size; guarantees of good sanitary conditions; good packaging; good survival rates on arrival and after sale.

A large share of the US retail market for ornamental fish is controlled by a few large companies, including Walmart, Petsmart and Petco, with a few large wholesalers/distributors controlling the supply of aquarium fish to the retail trade (Rana, 2002). The world's largest importers of aquarium fish are located in Miami and Tampa, Florida.

In order to return to the international market, and in particular to the neighbouring US market, Jamaican ornamental fish farmers would have to focus on organising and specialising in particular species of fish to be produced in large numbers, continuously and in controlled and constant quantities, also ensuring the absence of the most common diseases with appropriate tests. This requires, of course, a large and well-organised association of small entrepreneurs in the sector or the contribution of one or more investors with adequate managerial and international capacity.

This is what they do in mature ornamental fish production areas such as the Czech Republic, Singapore and China, where there are large numbers of small farms with groups specialising in a few or just one species. The groups are coordinated by one or more export centres that guarantee a high and constant production. The packing/distribution centres are responsible for marketing and maintaining quality standards.

Currently, the species most traded in Jamaica are: *Poecillids* (guppies, mollies, swordtails, platies), *Characins* (tetras), Tropical *Cyprinids* (barbs, danio), Cool Water *Cyprinids* (koi, carp, goldfish),

[5] In 2020, the top importers of Ornamental fish were the United States ($63.7M), China ($30.1M), Germany ($23.5M), United Kingdom ($22.2M), and France ($19.4M). https://oec.world/en/profile/hs92/ornamental-fish-live

Anabantids (fighters, gourami, paradise), *Cyprinodonts* (killifishes), Catfish (corydoras, pleco), *Cichlids* (angel, discus, oscar), Sharks (red tail, rainbow, iridescent).

Based on our observations, Jamaican producers mainly use a recirculating culture system, constructed from circular black PVC tanks (produced locally by the drinking water tank industry known as 'vats'), with volumes of 1 to 3 m3, connected by PVC fittings and recirculating gravel bed filters. This system is mainly used for grow-out, while self-made glass aquariums and other forms of tanks made from recycled materials are used for breeding.

In Jamaica there are about ten large and medium-sized ornamental fish farmers (but they are steadily declining), using earthen ponds for grow-out, recirculation system or open tanks, the latter covered with shade systems; some also run their own pet shops. Most are small-scale farmers with small-scale recirculation systems (about 30 - 50 m2) and often come from depressed urban or rural communities and can be defined as a hobbyists.

The feed used is mostly imported, typically: Aquamax 00, Aquamax 100+, Zeigler flake, Zeigler Koi stick, salmon starter, brine shrimp can; all available in pet shops that sell aquarium equipment. Farmers also use: Hi-Pro Tilapia Super 10 28% protein, egg yolk, canned sardine, oats, earthworm, brine shrimp (artemia salina), daphnia, mosquito larvae and self-made diets.

Objectives of this report

This report obeys to the general intent of analysing in depth the current situation in Jamaica regarding the farming of both food and ornamental fish with respect to their needs in terms of feed, the latter being the main cost factor in the production of farmed fish.

In order to have the most complete picture of the current situation and future potential of the feed sector in the local farmed fish industry, we have therefore adopted the following objectives:

1. to acknowledge the fish feed demand chain, i.e., how Jamaican fish farmers supplement their feed needs; what they use, in what quantities, at what conversion rate, and at what cost; what their needs and expectations are, and whether and how these are being met;
2. to know the fish feed supply chain; who produces fish feed locally: what kind of feed he offers to local fish farmers, in what quantities, what are the possible bottlenecks in production, what are the market issues and expectations; who imports fish feed: what are the types, quantities and costs of imported fish feed, what are the reasons for his import choice and what are the possible openness/willingness to change his purchasing habits; who finally self-produces the feed necessary for his fish production: what types he produces, with what machinery, what components he uses, at what costs and with what results in terms of food conversion;
3. to identify the growth potential of the farmed fish market; what are the limiting factors on the supply side, in terms of costs, product type and quality, production organization, supply aggregation and marketing; what are the limiting factors on the demand side, seen through the specifics of the various target sectors, in terms of product type and quality, minimum quantities and continuity of supply; what are the possible factors for unlocking the bottlenecks analysed and the relative growth potential of farmed fish supply acceptable on the demand side;
4. to identify the growth potential of the national fish feed sector; what are the limiting factors in terms of producers, raw materials used, product quality and differentiation, costs and volumes produced; what are the possible unlocking factors of the analysed bottlenecks in terms of producers and product and the relative growth potential of feed supply acceptable on the demand side;

5. to know the regulatory and legislative framework that governs the feed sector, both in terms of production, importation and distribution of feed and related components, and in terms of its use; to highlight the bottlenecks/inefficiencies and possible solutions.

Methodology followed

To carry out the analysis highlighted above, we differentiated the survey instruments to be used, being the demand side made up of a relatively large number of operators (theoretically around 134 operators), as opposed to the supply side, made up of a few feed producers/importers and equally few potential local suppliers of raw materials/sub-products that can be used in the fish feed industry.
To this end, we opted:

a. for the realization of a structured questionnaire to be submitted to a selected and representative number of fish farmers;
b. for direct meetings, in the form of interviews, with potentially all supply-side stakeholders; meetings aimed at obtaining the necessary data for the analysis of the following specific supply-side sectors: ready-to-use feed producers, fish feed importers and distributors, raw materials / components producers, usable by-products producers.

With regard to potential suppliers of by-products that can be used in the production of fish feed, a specific and new survey had to be carried out to identify potential interlocutors and their available contacts.
The questionnaire, in turn, was created in two slightly different versions, one specifically for Tilapia fish farmers and the other for Ornamental fish farmers. Despite maintaining the same basic approach, expressed by the sequence and typology given by the blocks of questions, some questions could only be asked differently, as they had to adhere to different production realities (see: Annex III - Tilapia Fish Feed questionnaire form; Annex IV - Ornamental Fish Feed questionnaire form).
The number of farmers considered significant for statistical purposes, since the time available was not compatible with a working hypothesis based on a sweeping survey, was estimated to be around 20% of the total (equal to the completion of 16 questionnaires for the Tilapia fish farms and 12 for the Ornamental fish farms). A percentage that, however, was not divided equally between the different farm sizes that characterize the two sub-sectors (Tilapia and Ornamental), favouring the larger farms, since they are the only ones to be full-time and currently accounting for almost 70% of the total volume produced.
More specifically, we've got:

-Tilapia & Ornamental fish farms questionnaires

As for Tilapia fish farms, 7 out of the 8 farms that constitute the largest farms (>20 acres), 2 out of the 10 medium-sized farms (6-13 acres) and 7 out of the 66 small farms (0-5 acres) were interviewed; of the latter only 51 farms appeared in production in 2021.
Concerning Ornamental fish farms, the major farms were interviewed, without however neglecting to interview also the medium and small ones.
The questionnaire was organized by blocks of questions, with the aim of having a succinct and at the same time complete restitution of the surveyed farm.
The questionnaire was not limited to qualitative/quantitative data on the feed used, but sought to take the opportunity of our presence in the farm to obtain, in addition to a picture of its consistency and management, valuable information about its problems/expectations and its willingness/propensity to

seek solutions in terms of reorganization and association, as these last aspects are those that most limit, according to our experience, the growth of the sector in general and in Jamaica in particular.
Coming to the description of the questionnaire used for Tilapia fish farms, we have:

- The first 3 question blocks aiming to frame the type of farm, describing its production cycle, the quantity of fish produced/sold, the unit size and selling price of the fish sold, the product outlet market.
- The fourth block having the function of describing the production site, the physical structures that compose it, the water and energy supplies, its hygienic conditions in terms of actions implemented to wash and disinfect the production surfaces and the equipment.
- The fifth and sixth question blocks having the task of describing the feed used, divided into purchased and self-produced, its type, quality (possibly with a brief description of the components), the quantities used, with their purchase prices, their conversion factor, if known, and the problems encountered in its supply (availability, price, quality, etc.). In case of self-production, a brief description of the equipment used is also required.
- The seventh block concerning the pathologies; if they occur, it is asked which are the recurrent ones, the severity of the events, the sanitary devices used to fight them and the means of protection activated to safeguard against their recurrence.
- The eighth question block asking about the main costs of farm operations, which in turn are divided by cost type: from the cost of operating/maintaining facilities and equipment to labour costs, from the cost of purchasing feed to the cost of purchasing water and energy, from the cost of purchasing services (veterinary/health, administrative, marketing, financial, security) to taxes.
- The ninth block aiming at investigating the willingness to change/improve one's internal organization and market presence through either outsourcing or pooling of specialized services or developing/improving such services internally.
- The tenth block concerning the farmer's evaluation of his own activity, from his own experience in the sector to the best practices applied in his farm, from the elements of his activity he considers strong points to those he considers weak points, from the risks/threats to the carrying out of the business to the challenges/opportunities he faces.
- Finally, the last two question blocks, the eleventh and twelfth, requiring the interviewer to add his comments about the surveyed farm and any photos of the farm production site.

With regard to the questionnaire used for Ornamental fish farms, the structure is identical to that of Tilapia, except that the block relating to feed is limited to the fifth, so the total number of question blocks is 11 instead of 12, while the topics covered in the respective blocks from number five onwards remain the same (6. Pathologies, 7. Farm management costs, 8. Self-assessment, 10. Interviewer's comments, 11. Photos).

-Feed Mills and by-products producer interviews

As for Jamaican feed producers, it was simply a matter of contacting the only two local companies, Best Dressed Feed Mill (owned by Jamaica Broilers), in the person of nutritionist Mrs O'Connor[6], which produces the only domestic fish feed, Hi-Pro Tilapia, and Caribbean Broilers, in the persons of Mr Winston and Mr Muller, which produces, through its brand Nutramix, all types of feed for animals

[6] A second meeting with Best Dressed Feed Mill Company included: Mr Jaime Ogilvie, Vice-President, Mr Dean Patterson, Feed Business Development, Mr Kirk Pennant, Hi-Pro Technical Advisor, R.D. Dennie O'Connor, Hi-Pro Nutritionist, Mr Hughes Collins, Feed Manager.

raised in Jamaica, minus fish, but which nevertheless makes available an interesting by-product of chicken and pork processing.

On the side of potential suppliers of raw materials/sub-products for the feed industry, the economic activities of a certain importance present in Jamaica that could potentially produce usable by-products were analysed and identified in advance. Subsequently, the companies owning these activities were contacted for an interview aimed at obtaining information about the available by-products, its quality, volumes and purchase conditions.

The companies contacted were:

- Ryco Ltd, in the person of Mr Kyle Tofte, which is a rendering industry producing poultry meal and fried regenerated oil;
- the Raw Sugar Manufactory, in the person of Mr Singh, which has the following sub-products: bagasse, final molasses (to be sold through Caribbean Molasses), press-mud;
- the Caribbean Molasses, in the person of Mr Hudson, which markets local molasses and imports molasses from South America for the Jamaican rum industry, and therefore has large quantities of this product;
- the Worthy Park Estate, in the persons of Mrs Stephens and Mr Clarke, which has sugar cane processing by-products, in particular: feed grade molasses, filtered press-mud, bagasse ash, sugar cane leaves;
- the Campari Group distilleries, which have a distillation waste called 'dunder' (vinasse), with a high BOD and COD content, to be disposed of;
- the Heineken Beer Industry, in the person of Mr McLean, which has the following by-products: spent grain (currently absorbed by the beef industry), cassava waste, fresh yeast in pasty form;
- the B & D Trawlers, in the person of Mr Francis, which is active in fishing and fish processing and has the following waste products: lobster heads, conch by-products and fish heads, tails and entrails; still in the fish processing sector, the remaining companies were also contacted: the Rainforest Caribbean, in the persons of Mr Kellier, Mrs Baychue and Mr Jardim, which owns two units (one in Westmoreland and the other in Montego Bay), and the Cools Seafood;
- the only two existing flour mills on the island, Jamaica Grain and Jamaica Flour Mills, which have an excellent by-product: the wheat middlings;
- finally, major catering and hotel chains were also contacted to assess the availability, volume and quality of leftovers, one being Sandals tourist hotel chain, in the person of Mr Jardim, also owned by Rainforest Caribbean.

The last phase of the survey of the fish feed supply-side sectors concerned the contact of importers of ready-made feed for ornamental fish. This kind of feed, as we have already seen during the first questionnaires provided and filled, is the main form of feed used by Ornamental fish farmers, which normally use to add it with home-made supplemental feed (artemia, daphnia, mosquito larvae, earthworms, eggs, self-produced paste, etc.).

The main importers of ornamental fish feed turn out to be: Nadwearl in Manchester and Exotic Bird Pets in Montego Bay.

Analysis of the Fish Feed Value Chain

The survey of Jamaica's fish feed value chain, i.e. the business and economic realities underlying the production, distribution and consumption of fish feed, paints a relatively simple picture of both the Tilapia and ornamental fish farming sectors.

On the production side, we have in fact only one domestic fish feed producer, whose pellet feed, designed for the grow-out phase, is used by almost all current Tilapia producers, in all growth phases, and also, albeit to a small extent, by ornamental fish producers. It is also worth highlighting the interesting presence of a very well organised feed self-producer in the Tilapia sector, as well as the widespread practice among ornamental fish farmers to self-produce a not insignificant part of the feed used, both as a supplemental feed and as a main feed.

On the distribution side, we have very few importers of fish feed, which in the case of Tilapia feed correspond to the two main farmers, while in the case of ornamental fish feed they correspond to the two major pet shops specialising in this type of hobby/farming. Sales take place mainly at the sites of the respective (production/import) plants, as a small network of shops ensures more extensive distribution for small quantities.

Finally, on the consumption side, we have a varied picture of farmers, the vast majority of whom are small producers, with very few medium to large sized, structured and organised farms.

Description of the quantities, qualities and costs of the different types of fish feed used

Domestic produced Tilapia fish feed

In Jamaica, the production of feed for Tilapia farming is the exclusive prerogative of Best Dressed Feed Mill, owned by Jamaica Broilers Group, which produces the only domestic marketed fish feed available in the island, the Hi-Pro Tilapia feed series.

The feed must be ordered in advance by the farmer. Before covid-19, various types were available from the company (from starters to grow-outs; see right below), while afterwards only the 9006-2 Tilapia 28 Super 10 type[7] was available, with some short breaks in stock due to technical problems with machinery. The company's policy in the last two years has therefore been to give priority to the production of feed for chickens and pigs, due to their larger market.

Hi-Pro Tilapia feeds available prior to Covid-19 were as follows:

- 9003-2 Tilapia 35, composition: 35 % protein, 4.7 % fat, 3.8 % crude fiber, 88.6 % dry matter;
- 9003-3 Tilapia 35, composition: 35 % protein, 4.7 % fat, 3.8 % crude fiber, 88.6 % dry matter;
- 9004-1 Tilapia 28 (Mash), composition: 28.4 % protein, 3.5 % fat, 4.8 % crude fiber, 88.8 % dry matter;
- 9004-2 Tilapia 28 (Pellet), composition: 28.4% protein, 3.6% fat, 3.8% crude fiber, 88.2% dry matter;
- 9006-2 Tilapia 28 (Pellet & Premix), comp.: 28% protein, 4.4% fat, 4.2% crude fiber, 88.5% dry matter;
- 9007-2 Tilapia 28 (High Salt), comp.: 27.3% protein, 5.1% fat, 4.6% crude fiber, 88.8% dry matter.

All of the above feeds use the same ingredients (see: below footnote #7) in different percentages to satisfy the fish diet at different stages of production.

[7] Whose feed ingredients, declared on the bag label (see: Annex), are: soybean meal, ground yellow corn, processed grain by-product, fish meal, mono-calcium phosphate, molasses, amino acids, fat preserved with antioxidant, sodium chloride (salt), vitamin A, C, D, E, K, biotin, choline, folic acid, inositol, niacin, pantothenic (B3), riboflavin (B2), thiamine (B1), pyridoxine (B6), cobalamine (B12), traces of cobalt, iron, copper, iodine, magnesium, manganese, sodium, sulphur, zinc, selenium, potassium, chromium.

Regarding the total fish feed produced by the company in the last three years, they declared:
-2021: 1,896 tons (consisting of 1,664 tons of Hi-Pro 9006-2 Tilapia 28 Super 10 Pellet and 232 tons of the other types of Tilapia feed produced upon order).
-2020: 1,575 tons.
-2019: 1,554 tons.
-2022 forecast: 2,200 to 2,500 tons, constituted again of the available Hi-Pro Tilapia feed types.
The average price of the best-selling type, the Hi-Pro Tilapia 28 Super 10, in 2021, was 115 JMD/kg.

In recent months, the Best Dressed Feed Mill has begun offering a new product: Pro-Pak® protein concentrate, H. J. Baker and Brothers. It is a cost-effective replacement for fishmeal in feeds, composed of a combination of high-quality marine, animal and plant protein (and yeast) by-products formulated to produce the same response as a high-quality (60-65%) protein fishmeal, including all essential amino acids. Proposed as a substitute for fishmeal (up to 50%), it had not, however, met the demands of the fish farmer. Also, after the last hurricane, the Best Dressed Feed Mill has started selling Menhaden fishmeal again (cost $2,478/Ton in international markets, plus Hi-Pro margin).
Regarding the extruded fish feed type, the company claims that it could import it if there is a large enough demand. In fact, the company has a low interest in fish feed due to its small market.

Always with regard to domestic production, it is interesting to note the presence of a self-producer, not so much for the quantities produced (obviously low), but for the exemplary nature of the fact. Mr Federyc Lyn is currently the only farmer who makes the feed he needs on the farm, self-producing pelleted feed from domestic by-products.
To do this, he uses mainly slaughterhouse waste, by-products of corn processing (corn leftover) and waste from coconut water production (in particular, the material inside, the copra, which, in its juvenile stage, is not very thick).
Mr Lyn is a small fish farmer, part-time, but very active, he has a mill, a kneader and a machine that produces pellets, the pellets are dried in the sun. Its Tilapia feed production capacity would be more than 3 tons per day, with the equipment fully operational. His limitations are of course given on one side by his few needs and on the other by the availability of feed components, which have difficult logistics for a small producer. He also does not have quality control over the components and finished feed, nor does he have a diet formula that meets the Tilapia's needs. The result however is a pellet that is well accepted by the raised fish, which just takes longer to get to commercial size.
Mr Lyn claims a very low production cost of about 30 JDM/kg.

<u>Imported Tilapia fish feed</u>

In addition to the Best Dressed Feed Mill that produces Tilapia fish feed locally, there are two farms that directly import fish feed for all their production stages, from hatchery to grow-out:
1) Longville Fish Farm;
2) DenCon Farms, formerly Algix.

Longville Fish Farm imports all of its feed needs from abroad. Mr Bunting, the farm's owner, decided to turn to the Danish company BioMar (imported from BioMar Costa-Rican headquarter through a trading company named Rerum Trading Ltd, whose CEO is Mr Newell), which offers feed for Tilapia divided into different types, for abt. 15% of his needs, to the Norwegian company Skretting, currently the world's largest producer of fish feed, for abt. 20%, and finally to the USA company SouthFresh Feeds for the remaining 65%. In 2021, Mr Bunting imported a total of 213 tons, divided as follows:

Feed Company name	Quantity (tons)	Cost USD/Ton
BioMar	33	800
Skretting	50	600
SouthFresh Feeds	130	400
Total	213	

Brief description of some types of imported feed currently used by Longville Fish Farm:

- *Biomar INICIO Plus for fry*

The new INICIO Plus pellets have a diameter size of 0.35 mm. They are optimized for covering the nutritional requirements of the smallest size fry and for giving an improved feeding experience at the very first stages of life for a fry. This extension in pellet size range of INICIO Plus offers a robust and sound growth for Tilapia.
BioMar's INICIO Plus feed covers all the nutritional needs of Tilapia during the first life stages. It is based on superior quality raw materials, contain high protein levels, balanced amino-acid and fatty acid profiles, vitamins and micronutrients. Due to its specially developed composition, INICIO Plus consistently out-performs in feed trials with excellent feed conversion, growth, and low mortality results. By improving the performance of the fish, BioMar's starter feed contributes to increased production profitability.

- *Biomar INICIO Cromis for Tilapia fingerling*

In addition to an optimised nutritional coverage at first feeding, the new INICIO Plus 0.35 mm pellets provide less dust and thereby lead to less feed wasted, compared to the use of granulates. Utilising INICIO Plus creates a cleaner water environment to the young fry. At these early life stages this leads to a better conversion of the nutrients contained in the feed. State of the art production methods and innovative design solutions secure slow sinking speed of the pellets, allowing for a good feeding success of the fry.
INICIO Cromis analysis: pellet (mm): 0.3-0.5; crude protein/crude lipids ratio: 60/10; type: floating.

- *Biomar EFICO Cromis for on growing (for semi-intensive farming)*

Line of diets developed with the objective of being able to offer high performance, with optimal energy levels for the correct development of tilapia in semi-intensive systems. Extruded feeds formulated under the open formulation concept (Performance Concept), which considers the digestible nutritional requirements (protein, energy and amino acids). EFICO Cromis is produced using high quality raw materials selected according to their digestibility. Floatability of between 80% and 100%, so that the producer can better control consumption and minimize his conversion factor (CFR).
EFICO Cromis analysis: pellet (mm): 3.0-4.5, 6.0-8.0; crude protein/crude lipids ratio: 36/10, 34/6, 32/6, 29/6; type: floating.

- *Biomar EFICO Genio for broodstock feeds*

The basis of a good production starts with the broodstock, that is why BioMar has developed the EFICO Genio line for broodstock, focusing on the quality of lipids required for the maturation of the female reproductive system for an optimal production of high quality eggs and larvae. Feed formulated with special attention to the quality of the lipids required for the maturation of the female reproductive system. Optimized digestible energy level and fatty acid profile, together with high amino acid availability provide the ideal nutrients for fish during vitellogenesis. Its formula contains nucleotides, beta-glucans, vitamins and other immunostimulant micronutrients. EFICO Genio is produced using raw materials of marine origin of the highest quality.
EFICO Genio analysis: pellet (mm): 7.0; crude protein/crude lipids ratio: 40/6; type: floating.
https://www.biomar.com/es-cl/costa-rica/productos-servicios/tilapia

- *SouthFresh Feeds Tilapia Floating Fish 32%*

Guaranteed analysis: crude protein, not less than 32.0%; crude fat, not less than 2.5%; crude fiber, not more than 7.5%.
Ingredients: plant protein products, processed grain by-products, grain products, animal protein products, fish oil, dicalcium phosphate, calcium carbonate, vitamin A supplement, vitamin D3 supplement, vitamin E supplement, calcium pantothenate, niacin supplement, ascorbic acid (vitamin C), menadione dimethylpyri-midinol disulfite, pyridoxine hydrochloride, riboflavin supplement, thiamine mononitrate, vitamin B12 supplement, folic acid, zinc sulfate, ferrous sulfate, sodium selenite, copper sulfate, manganese sulfate, ethylenediamine dihydriodide - *Ruminant Free*
https://www.southfreshfeeds.com/aquaculture-feeds/

DenCon Farms, formerly Algix, is the largest company in Jamaica, importing abt. 480 tons of grow-out feed, mainly from USA company SouthFresh Feeds (150 JMD/Kg), and abt. 3 tons of fingerling feed from Zeigler.

In the table below, you can see the details of Zeigler's available fingerling and grow-out feed types:

STAGE	TILAPIA DIETS	Crude Protein (Min %)	Crude Fat (Min %)	Crude Fiber (Max %)	Moisture (Max %)	Ash (Max %)	Phosphorus (Min %)	Floating	Slow-Sinking	Sinking	SIZES (MM)	PRODUCT SUMMARY
Starter	Finfish Pro-Start Vpak 55-15	55	15	1.5	12	12	1.8		•		Meal, #1 & #2 Crumbles	• Optimized formulation containing Vpak to provide a strong start to fry at first feeding. Suitable for cold-water, warm-water and tropical fish.
Fingerling	Finfish Pro-Start Vpak 50-15	50	15	1.5	12	12	1.3		•		1.5, 2	• An enhanced, high energy feed containing Vpak designed to transition fingerlings from fry feed.
	Finfish Hi-Performance	45	16	1.3	12	10	1.4	•			1.5, 2, 2.5	• A higher energy diet designed to help fingerlings transition to grow out feeds.
Grow Out	Tilapia 40-10	40	10	3	12	6	1	•			3, 5	• A versatile diet, this cost-efficient fishmeal-based diet is formulated to feed a variety of omnivorous and piscivorous aquatic animals with moderate protein requirements. Designed for RAS systems.
	Tilapia 36-6	36	6	4	12	7	1	•			3, 5	• A high performance, plant protein-based diet specifically formulated for tilapia cultured in intensive recirculating systems. It has a balanced amino acid profile and is highly digestible, resulting in low pollution. Designed for RAS systems.
	Tilapia 32-3	32	3	4	12	9	1	•			3, 5	• Designed for pond and cage systems.
Broodstock	Tilapia 36-6 Broodstock	36	6	4	12	5	1	•			6.5	• Designed to enhance the fecundity of your broodfish by helping maximize gonadal development. Contains vitamin and carotenoid pigment supplements required for viable egg and sperm development.

Total produced/imported Tilapia feed in 2021

In summary, given the quantities reported by the only producers and importers of food fish feed, the theoretical total feed consumed in 2021 in Jamaica in the Tilapia farming sector would be as follows:

- produced by Best Dressed Feed Mill: 1,896 tons
- produced by Mr Lyn: 5 tons
- imported by Longville Fish Farm: 213 tons
- imported by DenCon Farms: 483 tons

For a total of 2,597 tons of Tilapia fish feed theoretical consumed in 2021.

Ornamental fish feed

Feed for ornamental fish farming is generally imported. The main commercial ones are: Zeigler, Aquamax, flakes, koi sticks, fish meal, salmon starter and brine shrimp. Ration for Tilapia is also used, bought from the only domestic producer.

There are two main importers: Nadwearl in Mandville (Manchester) and Exotic Birds Pets in Montego Bay. In 2021, imported ornamental fish feed was about 11.5 tons, sharply down on 2019 and 2020 quantities (approx. 26 and 19 tons respectively)[8].

There are 31 pet shops in Jamaica (https://www.workandjam.com/bl/pets-livestock/pet-supplies), mainly concentrated in Kingston, of which 8 specialized in aquatics.

Ornamental fish farmers use not only commercial feeds but also home-made supplemental feeds, including: egg yolk, beef heart and liver, oats, green water, etc. Some farmers even make their own feed by combining different ingredients.

Since most farmers grow many different varieties of fish, calculating the amount of feed they use is very difficult. The prices of the main feed used are:

Zeigler koi stick: 2,000 JMD/lb

Zeigler: 800 JMD/lb

[8] Data elaborated by Aquaculture Branch from Jamaica Customs data on imported feed.

Zeigler flakes: 3,500 JMD/lb
Brine shrimp: 12,000 JMD/Can
Hi Pro 9006-2 Tilapia Super 10: 115 JMD/kg

There are some farmers who produce their own live feed (daphnia, artemia salina/brine shrimp, earthworms and mosquito larvae) and, according to the survey carried out, some (see: Henry Grant) produce a paste with different components. Again, there is no specific diet.
It's not uncommon to buy Hi-Pro Tilapia feed and complete the cycle with Zeigler feeds to give better coloration to the fish.
The two largest producers of ornamental fish, Competitiveness and Guardsman, purchased 500 kg and 1,350 kg of feed respectively in 2021. Feeds purchased included: Zeigler koy stick, Zeigler flakes and brine shrimp.

Description of the fish feed supply chain

Domestic production supply chain

The only domestic feed manufacture, the Best Dressed Feed Mill Company, for its Hi-Pro Feeds brand import all its feed components from abroad. The import duty is 20% and there are further 10% of other costs for delivery at the mill gate, which is abt. 50 km from the main port of disembarkation located in Kingston. The main imported feed components are: soybean meal, gluten corn, processed grains (wheat middlings and brewery waste; some quantities available locally), molasses (some quantities available locally), amino acid and fish meal. The premix is produced in Jamaica with imported components. The company imported 160,000 tons of corn and 62,000 tons of soy meal in 2021.
The company normally delivers the fish feed in its warehouse in Spanish Town. Only large quantities are delivered to the farmer's gate. There is a network of Hi-Pro Feeds agriculture shops (300) that sell fish feed bags in the Jamaica countryside. There is also a Hi-Pro Feeds farmer service directed by Mr Dean Paterson and Kirk Pennant, visiting 4 fish farms per month.
The Hi-Pro 9006-2 Tilapia Super 10 pellet price ranged from 114 to 116 JMD/Kg in 2021, depending on March 2022 survey by Alveo team supported by Aquaculture Branch staff (which has 5 extensionists that visit 8 farmers per month each; feed is one of the important subject that they take care).

Cluster: occasionally Longville Fish Farm (Mr Bunting) and DenCon Farms sell some imported fish feed (see: previous chapter) to other small and medium fish farmers. These days of March, Mr Newman, a Tilapia farmer of St. Elizabeth, bought some tons of BioMar grow-out feed from DenCon Farms.

Potential domestic by-product supplier

One of the main objectives of our field mission was to verify the consistency of Jamaican agri-food sector, since a large part of feed components are derived from its by-products; being also aware that its robust and proven tourism sector in fact cannot sustain itself without a good food chain.
All of which, of course, supported by the initial working hypothesis, namely, that only a domestic production system capable of supplying the local market with quality feed at a controlled price is the pre-condition for a decisive revival of the island's aquaculture, and that to achieve this, greater independence from abroad in terms of supplies is desirable.
In order to do so, we have carefully analysed the Jamaican agri-food sector, which appears, as supposed (see above) to be far from fragile and potentially very rich in opportunities.
In particular, we have found:

-Two industrial flour mills: Jamaica Grain and Jamaica Flour Mills Limited (JFM), owned respectively by the American company ADM Milling and the Jamaica Broilers Group; they both sell grain middlings by-product at 33,000 JMD/ton.

-The Heineken beer factory, which, as by-products, produces 3,500 tons of spent grain (sold at 1,500 JMD/ton to the beef producers), 540 tons of spent yeast (in pasty form, with abt. 20% dry matter) and finally cassava waste, the latter currently discharged as waste.

-In the area of meat processing by-product recovery, we have two well organised companies. An industrial chicken rendering plant in Clarendon, managed by Ryco, which produces poultry meal, supposedly in large quantities, with the following excellent characteristics: 58% protein, 11% fats, 3% fiber, 18% ash, 10% water (they recycle fried oil from restaurants too; web site: www.rycoja.com). The Nutramix factory, which, in addition to producing all types of feed for animals raised in Jamaica, minus fish, makes available an interesting by-product of chicken and pork processing.

-Again in the area of meat processing, this time of fish, we can mention: B & D Trawlers, active in fishing and fish processing, which has the following waste products: lobster heads, conch by-products and fish heads, tails and entrails; the Rainforest Caribbean, which owns two fish processing units, and the Cools Seafood, with one processing unit. These are nutritionally valuable wastes, but they would need a further processing step to be used as feed components.

-There is also the strong Jamaican distilled spirits industry (rum in particular), which not only keeps the island's sugar cane culture still alive, but also produces and imports (mainly through Caribbean Molasses) large quantities of molasses, which are also used as local popular feed component. This production chain, however, produces a number of by-products, currently unused, which could be used, in some cases after processing, as feed components: filtered press-mud (from the processing of molasses), currently used as a fertiliser, which has interesting nutritional characteristics that have already been successfully tested in carp farming; bagasse ash (from the burning of bagasse), also used as a fertiliser, which could be a source of supplementary minerals; sugar cane leaves, which could be a source of fibre, plant proteins and salts; and finally, dunder (vinasse from the distillation of molasses), currently a residue not easy to dispose of due to its high BOD and COD content. In this respect, information was collected from: the Raw Sugar Manufactory, the Caribbean Molasses, the Worthy Park Estate and the Campari Group distilleries.

-Finally, the strong tourism industry produces large quantities of food waste on a daily basis, often of very high nutritional value, which could be recycled within the animal feed sector with excellent results in terms of quality and economy, beneficial to both industries.

Trying to sketch an approx. yearly available feed components in Jamaica, we could have:

N	Component	Availability Ton	Cost JMD Ton	Water content %	Quality % protein
1	Middlings*	-	33,000	11	-
2	Bakery residues	-	-	-	high
3	Fish by products** fish meal	2,000	1440 USD	11	70%
4	Rainforest Caribbean fish+meat waste	70			
5	Chicken and pig rendering****	-	24,000	11	60%
6	Filtered press-mud	-	-	24	18%
7	Molasses feed grade	-	220 USD	27	-
8	Sugar cane leaves extract	-	-	80	-
9	Bagasse ash	-	-	10	-

10	Slaughterhouse residues	-	-	-	-
11	Brewery spent grain (BSG)	3,500	1.500	75	high
12	Brewery spent yeast (BSY)	540	-	80	high
13	Brewery spent hop***	-	-	85	-
14	Large tourist chain leftover	-	-	-	-
15	Restaurant chain leftover	-	-	-	-

* https://www.statista.com/statistics/1003493/jamaica-wheat-imports-volume/#:~:text=Imports%20of%20wheat%20in%20Jamaica,percent%2C%20totaling%20220%20thousand%20tons. (220,000 tons of wheat imported in Jamaica, whose processing produces abt. 26% of middlings, gives 55,000 tons of middlings potentially available in the island).

** Fishery and aquaculture country profile FAO 2017: 48,000 tons of imported fish and 16,800 tons of locally caught fish* and 1,200 tons of national aquaculture production (* by 21 landing beaches, 3 Quays -Kingston Harbour, Black River and Port Antonio- 87 Industrial vessels and 7,100 canoes 6-9 meters with 30-70 HP) make possible to recover abt. 2,000 tons of fish meal; it is not the best fish meal, but: https://www.indexmundi.com/commodities/?commodity=fish-meal.

*** Compared to BSG, the direct use of spent hops as feed supplement is not desirable due to the presence of 2-methyl-3-buten-2-ol, which is the product of bitter acid degradation and has hypnotic-sedative properties. Traditionally, spent hops have been used as a fertiliser and soil conditioner, due to the high nitrogen content or mixed with spent grain and sent to animal feeding. However, there are several compounds can be recovered from spent hops, such as flavours, saccharides and organic acids, which can be obtained after oxidation or hydrolysis of this material. Among these compounds, the hop acids, particularly, have antibacterial potential being a safe alternative to control bacteria.
https://www.intechopen.com/chapters/55749
Characterization and determination of brewer's solid wastes composition, Thiago Rocha dos Santos Mathias et others, 2015, wileyonlinelibrary.com) DOI 10.1002/jib.229

**** December 2021 Kingston.

Critical analysis of the fish feed value chain: strengths and weaknesses

Strength

1	Presence of two animal feed industries in Jamaica, one of which produces aquaculture feed; they have modern laboratories and machinery.
2	Two farmers import quality extruded fish feed.
3	A Tilapia fish farmer and some Ornamental fish farmers produce small amounts of feed themselves.
4	Currently, market demand for Tilapia is strong and at an attractive price for producers.
5	There is a distribution and sales network for Tilapia in Jamaica, currently traders are requesting more Tilapia for the market.
6	The largest producers, about ten, are more organized and use more advanced technologies, they could incentivize the others (if well organized).
7	Many sales of farmed fish take place at the farm gate, there is a network of live Tilapia sellers in Jamaica with stores equipped at farm gates.
8	There is an extensive network of sales of Hi-Pro feed consisting of 300 stores scattered throughout Jamaica, there is also a Hi-Pro service of technical assistance. There are great possibilities of communication not exploited.
9	There is a public extension service at the Aquaculture Division that monitors Tilapia and ornamental fish farmers.
10	There is a milling industry (two major industries) that produces middlings as a by-product.
11	About ten more advanced farmers produce half of all the Tilapia raised in Jamaica.
12	Some by-products of the food industry (beer industry, sugarcane industry, hospitality and catering industry, etc.) are available in Jamaica in interesting quantities to be used as fish feed components, there is an opportunity to create businesses in this sector, promoting the recovery logistic and by-products conditioning.
13	In Jamaica there are qualified nutritionists.

14	Some fish farmers (Wilson and Lyn) have semi-industrial mechanical workshops and can build and operate feed industry machinery.
15	Some private entrepreneurs have capital available in Jamaica, particularly large fish farmers.
16	The largest farms have competent owners who are aware of the available and applicable technologies and therefore choose the right technical and commercial strategies.
17	Some farms already cooperate with each other.
18	There is land, water, and ponds not in use, available to increase Tilapia production. In general, the capacity of the productive infrastructure for Tilapia farming is under-utilised in Jamaica.
19	Imported feed allows for a faster production cycle, 4-5 months versus the current 7-8 months.
20	The Aquaculture Division hatchery will be renovated with the capacity to produce 5 million Tilapia fry/fingerlings per year. There will be a significant increase in demand for starter and pre-starter and for brood stock quality feed.
21	There is an executive project for intensive saltwater shrimp farming, an additional customer for the feed industry. High quality feed will be required.
22	The economic return for Tilapia farming in Jamaica is very attractive at this time.
23	No major diseases in Jamaican farms.
24	There are public research institutes and private universities that can develop R&D for available Jamaican by-products, particularly on solar energy for drying.
25	In the past, the contract farming system was well used, current conditions would be very favourable.

Weakness

1	Fish feed produced in Jamaica is not extruded and is considered to have poor performance by farmers. There have been issues with feed availability in 2021.
2	The only two industries that produce feed do not have the extruder that would allow for higher feed quality.
3	Feed price is considered high by farmers.
4	The vast majority of feed components are imported; only middlings and molasses are produced locally. Imports are taxed at 20%: both for feed and feed components.
5	The quality of the self-produced fish feed in Jamaica is poor and not manufactured with the principles of nutritionism, however it has a very low price.
6	The vast majority of fish farmers are small sized, so they have other activities besides fish farming that allow them to make a living.
7	Medium and small fish farmers would need more technical assistance, not using and being not aware of the existence of more adequate technologies.
8	Aquaculture Division service says it is underfunded and understaffed.
9	Modern field data retrieval systems (see web platform) are not used for fish farming production and feed use.
10	There are no demonstration sites for the use of feed and technologies for fish farming.
11	There are no specific financial instruments for domestic feed purchase and feed import logistics, and in general there is a lack of financial products dedicated to aquaculture.
12	There are several types of feed for Tilapia in Jamaica (Hi-Pro), but due to a number of issues only Tilapia grow out (Type 9006-2) with 28% protein is used, the starter is not used. This implies more time to get to commercial maturity of the fish.

13	The Aquaculture Division's current hatchery does not produce enough fry for the demands, especially for medium and small breeders. Periodic importation of selected parents would be desirable to increase the genetic variability of local Tilapia varieties.
14	The associationism of the fish farming and ornamental fish sector is not well developed, despite this, the largest farmers sell inputs (feed and fry) to some smaller ones in their vicinity.
15	All available food by-products need processing (some only drying) to be suitable for feed production.
16	Feed and feed components are all equally taxed at 20% on import, with no differentiation.
17	The local feed industry focuses on poultry and pork production, which are considered more profitable; fish farming is not a priority.
18	The aquaculture sector in Jamaica is disorganized and does not take advantage of the natural, market, and by-product capabilities currently present in the island.

About ornamental fish in particular:

Strength

1	Presence of adequate production structures with ample room for development.
2	More than 300 farmers trained by The Competitiveness Company.
3	Presence of competent farmers.
4	Large international market, in particular the USA with a large customer base within easy reach in Florida (2 hours flight time and large capacity in the hold).
5	Quality ornamental fish feed imported, with continuity of supply, from at least two commercial facilities.
6	Some farmers interviewed produce live manure (daphnia, artemia and mosquito larvae), and others produce fresh mash for ornamental fish larvae.
7	Some farmers use Tilapia Hi-Pro feed, always available on the market, especially for Cyprinids.

Weakness

1	Domestic market with limited uptake of ornamental fish.
2	Lack of new ornamental fish species to enlarge the market.
3	Absence of exports.
4	Problems with ornamental fish survival in the past.
5	Volatile approach to the market.
6	Absence of a structure to deal with ornamental fish exports (Competitiveness no longer operational as of December 2021).
7	No technical nutritional expertise or experts in fish food technology among ornamental fish farmers.
8	The production of ornamental fish feed is done empirically.

Determination of the potential demand for fish feed based on current and future projected production

In order to try to understand the actions and investments required by the fish feed sector in strengthening itself to support the desired development of the Jamaican aquaculture, an initial dimensioning of its consistency, in relation to both present and short-medium aquaculture state, is necessary.

In the given state of affairs, we have seen that approximately 2,600 tons are sufficient to cover the current Tilapia feed needs; of this quantity about 1,900 tons are supplied by the only national fish feed

producer, while the remaining 700 tons are imported. We have also seen that the reason for this importation is linked to the poor quality of domestic feed and the low price difference between domestic and imported feed, the latter being however considered to be of higher quality, i.e. able to reach the sales weight in much less time (thus allowing the two largest farms, the only ones importing, to carry out more production cycles per year).

Assuming an average of 250 working days/year (252 working days in 2020 for Jamaica), to fully meet the current demand for Tilapia feed, we would have to produce an average of about 10.5 tonnes/day of feed, which would be easily achieved, for example, by a compact 2 tons/hour mini-plant.

As for ornamental fish feed, currently almost entirely imported (apart from that unknown fraction of supplemental homemade feed), the 2021 import figures tell us that only 11.5 tons are consumed by both hobbyists and producers, i.e. a quantity so low that it would be virtually covered by a feed production of less than 50 kg/day.

So, how much could the demand for fish feed increase in the coming years?

Tilapia fish feed

The first data we can try to represent concerns the ratio between feed consumption and Tilapia harvested; in fact, by providing us with the average Conversion Factor Ratio (CFR), i.e. the average feed consumption per harvested fish, it makes it possible for us to assume for a certain amount of fish to be produced the feed necessary for its production.

In order to do this as accurately as possible, using the latest available complete data for 2021[9], we believe it is useful to first separate the imported from domestic feed data. The first in fact refers only to the two major farms that import feed to meet their own production needs (the small amount destined for occasional sale to neighbours is not considered here), while the second refers essentially to the feed consumption of the remaining farmers.

DenCon Farm produces, with about 483 tons of imported feed, about 184 tons of fish, giving a ratio of just over 2.6 kg of feed consumed per kilo of fish produced, while Longville Fish Farm produces a similar amount of fish, about 175 tons, but imports only 213 tons, giving a feed/fish ratio that is not only unbelievable compared to DenCon but also (by adding to harvesting data the mortality declared in the grow-out stage; see below) compared to the CFR literature on Tilapia. The 232 tons of domestic Hi-Pro "non-standard" fish feed produced on demand are therefore likely to cover the remaining needs of Longville Fish Farm, thus bringing its feed consumption to 445 tons, which would give a feed/fish ratio of 2.5-2.6 kg of feed per kilo of fish, more credible and similar to that of DenCon.

The remaining 1,664 tons of domestic Hi-Pro fish feed (the "standard" Tilapia 28 Super 10) would therefore have been used in the production of the remaining 511 tons of fish, giving a ratio of approximately 3.3 kg of feed consumed per kilo of fish produced.

The difference between the two feed/fish conversion ratios, 2.5 vs. 3.3, is most likely related to a slight change in the mortality rate. In the grow-out phase, when the fish consume the most feed, the reported mortality is always between 30% and 50% (mortality related to theft and animal predation - birds and crocodiles- as we have seen), so if we were to subtract 30% from the feed/fish ratio of 2.5 we would get a ratio about 1.75, while subtracting 50% from the feed/fish ratio of 3.3 we would get a

[9] Data 2021 from:
- harvested fish - Aquaculture Branch, direct on-site survey at farmers' premises through its extension service;
- imported fish feed - Aquaculture Branch, elaboration of Jamaica Customs data on imported feed;
- domestic fish feed - Alveo Team, direct on-site survey at manufacturers' premises.

ratio of 1.65, i.e. similar values and moreover compatible with the CFR literature on Tilapia when fed with medium quality feed.

Assuming that no future action will be taken on reducing mortality, by means of predation control systems, and therefore maintaining a ratio of about 1 to 3 between fish harvested and feed consumed, a hypothetical doubling of current production of Tilapia to be achieved in the next couple of years would bring the feed requirement to about 5,250 tons, which can be met with a production of about 21 tons/day, achievable by a small compact plant of 3 tons/hour.

Such a fast increase in fish production, from 870 tons in 2021 to the 1,750 assumed above, would in fact be more than compatible with the current acreage in production, which was 698 in 2021 (data from Aquaculture Branch extension service survey). In other words, there do not seem to be any particular bottlenecks on the current production structures front; 1,750 tons of fish would correspond to approximately 5,250,000 fish at 330 grams/capita (the average weight on sale), which would imply a reasonable density of approximately 2 fish/m2 at harvest.

So, while doubling production in the short run would be possible in technical terms, both on the feed production side and on the infrastructure side, from the point of view of the market players, farmers and customers, would it be possible?

According to various interviews carried out by the Alveo Team (in collaboration with Aquaculture Branch extension service), we can state: a strong optimism about the market demand for farmed Tilapia (potential market being much larger than current); a strong increase in the demand for fry and feed, not completely satisfied in 2021, mainly for covid-19 restrictions; the larger farmers willing to increase their production once the feed supply conditions become sustainable in terms of delivery ease, quality and price.

Finally, as far as the market is concerned, it should be considered that:

-current sale price of Tilapia at the farm gate stands at (450 JMD per pound) 990 JMD/kg;

-the average domestic feed price was 114 to 120 JMD/kg;

-even assuming a FCR of 3 (3 kg of feed for 1 kg of fish; see above) the feed producing cost would be 360 JMD/kg.

Being so, the good profitability of Tilapia farming would allow a fast growth of the Tilapia business and thus ample opportunities for improvement in the feed sector as well, which in turn may be reflected in higher farm productivity. Considering also that there are many inactive farms, unused ponds and ample space available in the vicinity of active farmers, there would even be a large potential of increase in production, much higher than the doubling assumed above.

<u>Ornamental fish feed</u>

Regarding ornamental fish, current data show a continuous (and apparently irreversible) strong decline in active farms (from 75 in 2017 to 50 in 2021) and even more so in their production capacity.

Also, during the interviews phase, it was seen how Jamaica's largest farm and exporter, The Competitiveness Company, closed in December 2021 due to significant (and already described) economic difficulties, mainly related to the inability to sustain exports, as well as Lance McDonald.

Dry specialised feed is exclusively imported; the import quantity is extremely low, set at 11.5 tons in 2021. It is easy to imagine that, with exports definitely closed (by closing of Competitiveness), the sector is destined for further decline until it reaches an equilibrium point in the domestic market alone. As a result, consumption of specialised feed will continue to fall in relation to the already very low quantities imported, making this feed sector unworthy of investment and attention.

Basically, as already stated in the previous pages, professional ornamental fish farming can only be revitalised by concrete and decisive actions aimed at export. These, in turn, are not currently limited by the availability and price of specialised feed, but by an organisational, productive and commercial structure capable of solving the well-known problems associated with export.
At present, in a sector now limited to the domestic market, almost all farmers, most of them at a hobby level, produce their own live food, such as mosquito larvae, brine shrimp and daphnia. Some of those interviewed produce fresh home-made mash of various kinds, without specific knowledge of the needs of the (numerous) species they raise and without specific technical assistance. The few remaining farmers, while pointing out that feed prices are very high, have marketing concerns and many are declaring that they are operating at break-even or even at a loss, partly due to the fact that the ornamental fish for sale in local markets are small and are sold by unit rather than by weight.

Assessment of the national capacity, current and potential, to produce quality fish feed

Today, the Jamaican feed industry is represented by Jamaica Broilers, with its Best Dressed Feed Mill factory, which produces the only domestic fish feed (Hi-Pro Tilapia), and Caribbean Broilers, which, under the Nutramix brand, deals primarily with poultry and swine and does not produce fish feed.
These two companies are modern with related machinery, analytical laboratories, nutritionists and a good technical support service for farmers; both are also part of international groups. They work with good feed production practices and are well known in Jamaica in the farming sector. To date, they have not shown much interest in the fish sector as it does not have large markets. Therefore, only one has a line of fish feed and in practice only offers a 28% protein type for grow-out (Hi-Pro Tilapia Super 10) and has not yet been interested in acquiring an extruder to improve feed quality.
About current production capacity of the unique local fish feed facility (Best Dressed Feed Mill), from a quick visit to the plant, we can say that it is surely greater than that put in place for 2021 production (1,986 tons of its Hi-Pro Tilapia) and the company itself states that it expects a 30% increase in its fish feed production in the current year 2022, of course without having to make any changes to the installations. With regard to product improvements, by up-grading the plant (i.e. purchasing the extruder), they were willing to buy extruded feed from abroad to resell if there was sufficient demand.
In addition to industry, we have visited a fish farmer, Mr Fredrick Lyn, who produces several tons of feed per year for his own 6 Tilapia farming ponds. Mr Lyn has a mill, a mixer and a machine to make pellets. He could produce 3 tons per day of feed without any problems. The quality of the feed is poor, as he is not assisted by a nutritionist for formulation, but the components he uses are cheap and local, such as chicken/pig rendering, corn scraps, molasses and copra. Mr Lyn states 0.2 USD as the cost of one kilogram of feed. The fish produced takes more months than those produced with industrial feed, but the production costs are laughable and the profit margins excellent. His biggest problem is the availability of feed components.
Given the above picture and with regard to potential production capacity, we can say:
-On the industrial side. The doubling of feed consumption projected for the coming two years should not encounter any technical constraints in the existing installations, under the same conditions of types and quality of current available feed. The issue would be different if this greater quantity were to be of higher quality and with differentiated types continuously available; in this case, according to them, there is limited interest in investing in the purchase of an extruder and to make different fish feed types (pre-starter, starter and on-growing) continuously available, since fish farmers represent less than 1% of their customer base.

-On the artisanal side. Mr Lyn could significantly improve the quantity and quality of his feed. He should be well assisted on the nutrition side of formulating diets, setting up some few equipment to produce components and pellet with a finer diameter and sourcing locally produced components. A further possibility could be to install a new compact mini-plant unit specialized in the production of fish feed, considering also that the same machines can be used for the production of pet food and ornamental fish feed; these technologies are available in the markets. Also, some mechanical engineers (Mr Lyn and Mr Wilson, who own well equipped mechanical workshops) could copy some machine and maintain them appropriately. As mentioned above, the main machines to produce feed are: mill, mixer, extruder, dryer and bagger. Some silos may be used to store components and finished pellets.
-On the feed components side. Some components must be surely imported (mainly, vitamins and minerals for the "premix"), others can be bought from domestic producers (fishmeal from Best Dressed Feed Mill; wheat middlings from Jamaica Grain and Jamaica Flour Mills; brewery waste –yeast and spent grain- from Heineken; molasses from Caribbean Molasses; poultry meal and meat/bone meal form Ryco and Nutramix), further others may be available after processing (like, for example, filtered press-mud, fish waste, catering waste, cassava waste, fresh pasty yeast, dunder, etc., which must be dried for use in animal feed; conversely, they can be cooked and used in the form of fresh paste).

Just as a small example, here below a Tilapia diet with 37% protein maximizing the use of local available products:

INGREDIENT	INCLUSION
Meat & bone meal (48%)	10
Poultry offal meal	26
Trash fish (whitefish-mixed)	5
Wheat middlings**	34
Yeast (brewers)	20
Vitamin/Mineral premix*	1
Salt (NaCl)*	0,5
Dicalcium Phosphate*	0,5
Copra (coconut) meal	3
TOTAL	100

*Imported products
**Sugar cane "filtered press mud", with 18% protein, can be inserted in the diet at the 15% content in place of middlings.

Assessment and review of the regulatory framework for the production, importation and distribution of fish feed

Jamaican legislation and regulation regarding the production, importation and marketing of feed is very simple, which in itself is a good thing as it makes it easier for the local producer to operate in the sector, especially since the locally produced feed is only destined for the domestic market.
Certainly, the descriptive part set out, for example, in the Fertiliser and Feed Act schedules would need to be revised, as technology has made unquestionable progress in the 50 years following its last revision (in 1973) and has brought many innovations, including conceptual ones.
In the case of imported feed health safety, random checks on entry into the country are normally sufficient to ensure the absence of toxins or undesirable and illegal elements/components.
Still on the subject of imports, the fiscal part (linked to customs duties) could be made more functional in terms of promoting or discouraging the import of certain products or components so as to create

favourable conditions for local production where this overlaps with the equivalent imported product, obviously using flexible criteria.

Feed legislation

Fertilizer and feed act, 1942 (amended in 1973)

In the initial part there is a description of the power of inspection and the penalties that state inspectors can make to those who do not comply with the dictates of the Act.

In Schedule 1, Part II, there is a description of the livestock feeds found in commerce with their characteristics.

In Schedule 2, part II, there is the obligation to declare the contents of the food such as fiber, protein or other.

In Schedule 3, there is a list of added components that must be declared in feed, such as wood, straw, bagasse and fibrous epidermis of fruits and nuts.

In Schedule 4, there is a description of feed components that may be placed on the market.

In Schedule 5, Part II, there is a description of undesirable ingredients in feeds and feed components, such as sand, poison, and salt.

Standards

The only standards in Jamaica with regard to feed are issued by the Bureau of Standards and are primarily aimed at the poultry industry, but contain some reference to the feed manufacturing industry. They are:

-JS CRS 29 2011 - Jamaican Standard Specification for Poultry Feed and Feed Ingredients.

SKU:JS CRS 29 2011

-JS 147 1999 - Jamaican Standard Specification for General Method for the Detection of Salmonellae in Food and Animal Feed.

SKU:JS 147 1999

-Other on chicken farming standards.

Finally, another important chapter concerns the importation of feed and its components. The procedures for imports are as follows:

-Apply to the Veterinary Service Division permit to import fish; the origin certificate and the name of the producer to complete the risk assessment is needed. This permit has 3-month validity and is single-use (this depends on the “Animal disease importation act” and “Animal health Act”).

-Pay the custom charge that now is 22% of the value of the feed. This depends on form “Customs Act”.

Activities in feed legislation

Animal health Act revised new draft is in preparation. Could be a good occasion to add some areas about “feed safety” and “feed good practices” regulation.

The Time Frame

This chapter briefly describes the main facts about the field mission, the operational choices in conducting the survey, the tools used, the actions carried out in collaboration and with the support of our Jamaican colleagues and the Aquaculture Branch, the novelties encountered, the positive and interesting things, the problems faced and the solutions identified.
The aim is not only to draw up a kind of logbook, but to describe the reasons and motivations for practical choices aimed at charting the best possible route, i.e. one that is more in keeping with the peculiar Jamaican reality, for the development of the country's aquaculture.

The Kobo Toolbox instrument organization

The last experience in Cambodia in 2021 had led Alveo members to use a very practical IT platform to standardise and facilitate field data collection in the aquaculture sector; the Kobo Toolbox platform, a free, well known and quite widespread data collection sw used to ease surveys by NGOs and public administrations.
The Kobo Toolbox describes itself as: a simple, robust and powerful tools for data collection, used in the most demanding contexts, created by users for users, with easy form creation, to buid-collect-analyze data on-line or off-line (see: https://www.kobotoolbox.org/).
It was therefore decided to propose this tried and tested IT platform also in the Jamaican project to automate the questionnaires phase and create a simple and easily searchable database.
On the questionnaire architecture (see: Annex III - Tilapia Fish Feed Questionnaire form; Annex IV - Ornamental Fish Feed Questionnaire form), we have already written in the chapter concerning the "Methodology followed" (we are pleased to mention here the compliments on its accuracy received from some important stakeholders interviewed).
The two types of questionnaires developed (Tilapia and Ornamental Fish) were made available to the Aquaculture Branch by providing them with the 'operational' link (the only one that allows to modify the questionnaire) to the pages of the Kobo Toolbox website where the questionnaires are stored, for a total sharing, i.e. with the possibility for the director or his staff to intervene directly on the questionnaire structure, on the questions and their sequence.
The link made available to the extension service, on the other hand, concerned only the possibility of completing the questionnaire, without making any changes to its architecture, in order to avoid compatibility problems between completed questionnaires during the final data processing phase. In fact, the Kobo platform gives the possibility of producing a file in Excel format with all the data collected, which is very useful for subsequent elaborations.
The work set out had three main objectives:

- the first one, to ease the work, using a tablet (linked to the online questionnaire) or a mobile (by installing the Kobo Collect App, also free), instead of a clipboard;
- the second one, to avoid transcription errors, occurring when passing from paper questionnaire to computerised one;
- the third, to produce graphs and reports immediately, as well as producing an Excel file in which each line corresponds to a completed questionnaire, with the related data in the columns, thus being able to process and compare the data at each stage of the work.

The programme also has some other very interesting features for fieldwork such as that carried out by the extension service:

a) the possibility of geo-localising the data entry points, with relative geographical coordinates, and accompanying them with geo-referenced satellite cartography;
b) geo-localisation carried out by data entry points also makes it possible to draw/map polygons of which the geo-localised points are the vertices;
c) in the same way, it has the possibility of measuring distances, using Google Maps and similar applications with which Kobo communicates;
d) in addition to the functions Reports (which shows graphs and averages), Table (which highlights all the questionnaires), Gallery (which collects the photos taken in the various questionnaires) and Download (which downloads the compiled data in Excel format, as mentioned above), it also has the Map function which shows on a satellite map (Google Map and others) the various locations of the questionnaires carried out through the geo-localisation function within each questionnaire;
e) the possibility of inserting drawings (typically, layouts) made directly using one of the programme functions, as well as photographs;
f) finally, points a) and b) provide the possibility of linking the questionnaire and its mapping to an existing or future GIS.

Basically, it is a simple tool to use, but quite complex in its functions, which could be used in the farm survey routine by the extension service in a perspective of computerisation of the service itself (see following paragraph: "The problems met and the solutions identified") and, why not, also by the farmers, who could, as we will see below, compile the data themselves using the IT tools, starting from Kobo Toolbox, made available to them.

The Aquaculture Branch capacity building

The Aquaculture Branch of the Fisheries Division of the Ministry of Agriculture & Fisheries has the institutional task "*to provide the support mechanisms needed to foster the sustainable development of the Aquaculture sector.*

This is achieved through the following:

1. *provision of Extension Services to fish farmers*
2. *provision of other support services including sale of high quality ornamental and food fish seed stocks*
3. *engaging in adaptive research of economically important species of freshwater flora and fauna and*
4. *training and technology transfer*"

(cited from: https://www.moa.gov.jm/content/roles-and-functions)

In a nutshell, the service was and is our ideal and practical technical referee and partner.

The personal familiarity with the majority of the Aquaculture Branch members (the director and the most of the extension officers) by the Team Leader, who had already worked with the same people during the project design in 2016, with good results, greatly facilitated the task.

Being so, we could have a very good and cooperative relationship with the director Mrs Smikle from the very beginning. The director readily provided us with the data collected on fish farms (pond acreage, fish harvested, feed consumed, etc.) by the extension service for previous years. Complete 2021 data on fish farms and Customs fish feed imports were provided us as soon as they were processed, during the 3rd week of March; it's worth recalling here that on the provision of these data depended the outcome of the analysis related in this report.

The director also organised a couple of technical meetings with the extension officers, making some of them available to the Team Leader, as well institutional meetings with relevant stakeholders from both public and private sector, and accompanied the Team Leader on very interesting missions (see: Annex I - Mission reports).

With the extension officers kindly made available to us by the director, we made 4 visits to the main farmers and completed some of the 28 questionnaires foreseen in the work programme previously agreed with the Aquaculture Branch (see: Introduction - Methodology followed).

In order to ensure that the questionnaires, the architecture of which had previously been submitted to and approved by the Aquaculture Branch, were completed correctly, we first organised a brief capacity building workshop on the use of the survey tool identified, the Kobo Toolbox App for data collection (see above). The objective of the capacity building was to train the extension officers in the use of the App on their tablet, as well as to understand the survey approach, illustrating the structure of data collection, based on thematic blocks of questions, the format of questions asked (with typed answers in "select one" or "select multi" or "matrix" format), etc.

In order to facilitate the compilation of a fairly complex questionnaire, as it aims to obtain a relatively complete picture of the activity investigated, albeit in synthesis (see: Annex III - Tilapia Fish Feed Questionnaire form; Annex IV: Ornamental Fish Feed Questionnaire form), the extension officers who were already familiar with the surveyed farm were advised to pre-fill the sections for which they already had the required information, limiting the interview to those questions for which they had no data or of which they were uncertain. The interview could be carried out either directly or by arranging a telephone appointment with the farmer.

Getting the Kobo Toolbox App running on the tablets used by the extension officers was perhaps the most complicated part of the whole capacity building exercise. This is actually a simple link to the questionnaire placed online on the Alveo page within the Kobo Toolbox website (the link to which has been passed to the Aquaculture Branch for future use), but at first the Aquaculture Branch IT expert was unable to activate the link due to supposed software problems. We therefore had to ask the software specialist Mr John Thompson (who works for the Fisheries Division IDB project) for support, which in just a few minutes installed the program link to the extension officer tablets. For reasons unknown to us, the extension officers refused to install on their mobiles the Kobo Collect App (another simple and convenient technology offered by the Kobo Toolbox software).

The extension officers who participated in the capacity building and then in the compilation of the questionnaires were:

Mr Keno Garvin, who completed 3 Tilapia and 7 ornamental fish farm questionnaires;

Mrs Leanne Morris Bennett, who completed 5 Tilapia and 5 ornamental fish farm questionnaires.

The remaining 9 Tilapia and 3 ornamental fish farm questionnaires were completed by the Team Leader in cooperation with our local expert Mr Derrick Spence.

The time to complete a questionnaire in the field or by phone is about 30 minutes for the more complex farms.

The field missions

The field missions were carefully prepared in order to visit and interview the main stakeholders identified both through the data provided by the Aquaculture Branch (in particular regarding the farmers followed by its extension service) and through an ad hoc study on the size of the Jamaican

agri-food sector, its main actors and in particular those who could be possible suppliers of useful by-products in feed production.
The visits and meetings therefore covered institutional actors (Aquaculture Branch, National Fisheries Authority, Ministry of Agriculture & Fisheries and Customs), the main farmers, the only two feed producers, the main pet shops specialised in ornamental fish, agri-food producers of interest, the main fish market in Spanish Town and some higglers.
For details on these missions, see Annex I - "Mission reports".

The problems met and the solutions identified

The data collection campaign for the completion of the present Situation Analysis report was, on the whole, relatively easy to conduct, with no particular problems or incidents (apart from the unfortunate car accident involving our local collaborator, Mr Spence).
Always well supported by the Director of the Aquaculture Branch, Mrs Smikle, and the Project Manager in charge of the World Bank, Mrs Ledgister.
However, this campaign has given us the opportunity to note some inefficiencies in the realities we have come in contact with, which we are pleased to point out, with some indications as to what could be improved.
Extension service
-About logistics - Visits are the best way to maintain a lively relationship with farmers and provide the best extension service. However, as they represent the biggest cost in the service budget, some practical measures to at least improve the logistics and lower their cost impact would be desirable. Considering that the officers currently go on missions alone and that the majority of farms are concentrated in a few areas, it would be possible to group the officers by area, to organise a common visit day and to use the same means of transport, and why not, organise it even in cooperation with the other existing extension services in the same area. Consequently, we suggest to carefully plan visits in such a way as to optimise time and resources, in this also facilitated by the points set out hereunder.
-About IT - An adequate information technology applied to ease service tasks could be of great help, if well designed and implemented, both in terms of internal service management and in terms of additional service provided to farmers. By way of example only, it could concern the scheduling of visits (see above), the filling in of the questionnaires and the subsequent administration of data, as well as the simplifying of certain field operations, such as biometrics, pond measurement, survey of structures / infrastructures, etc., and also more the proceeding of purely bureaucratic activities (licences, health checks, possible subsidies or funding, etc.). It could also be planned, in the near future, the creation of an Aquaculture Branch's own website with a section dedicated to farmers, where they could meet programmes and initiatives, simplified (user friendly) questionnaires to be filled in on-line (after a short training and eventually bonus), short and simple on-line training courses, etc.; so as to have a greater involvement of farmers in the programmes and objectives of the Fisheries Division of the Ministry of Agriculture and Fisheries.
-About farmer relationship - Having a good relationship with farmers, based on trust and recognition of service benefit, is fundamental to any successful extension service. This aspect should not be underestimated at any time during the extension officer's activities, from the booking of pre-arranged visits (compatible with the logistics above), with visit subject well in evidence, to the sharing of work programmes, very basic with the simplest and smallest farms, more structured with the largest and most active farms. It would also be desirable to set up a programme to monitor farmers' satisfaction

with the services provided; this could in future be made available online in the Aquaculture Branch's web platform for farmers (see above).

-About aquaculture technologies - The extension officers could, possibly following the creation of a few ponds to use as examples at the Aquaculture Branch Hatchery, further promote the use of green water technology to farmers, given the fairly extensive nature of their aquaculture practices. To improve fieldwork and farmer aid, it would be advisable to equip extension officers with a water analysis kit, feed quality control systems and basic knowledge to diagnose the main Tilapia diseases in the Jamaican environment; It would also be helpful if they were able to assess the scale of natural predation and the presence of fauna coexisting with the farmed species, possibly suggesting simple defence means of predation protection.

-Training - An internal training programme on the afore-mentioned points would be desirable, as well as training programmes for farmers, the latter differentiated not only by topics but also by different degrees of expertise and farm size. Part of the farmer training programmes could be successfully transferred to the Aquaculture Branch web platform above cited.

Farmers

By interviewing the farmers, especially the medium and small ones (accounting for about 90% of the total), we realised that they often have a very approximate knowledge of their water areas, fry stocking densities, feed consumption and fish production (and therefore the mission data have to be considered with a certain "deviation" for this set of reasons). In this case, too, it would be very useful to set up a web platform dedicated to farmers (see above) that would allow for online data entry (even by self-insertion), obviously guaranteeing data privacy and encouraging the farmer to keep his data updated. Data could be per pond and per cycle; these data may also be updated/validated by telephone by the extension service. Existing geo-referenced information cartography (GIS) and special software, manual or not, can help in the measurement of pond surfaces with sufficient accuracy. Currently, pond surface could also be measured directly during visits, using a trained walk as a tool; knowledge of pond surfaces is indeed important, being one of the main production factors.

Some considerations on collected data on Tilapia farming

Data on harvested fish, and its selling price, feed consumption and spawning density formed the main topic of the submitted questionnaires, along with numerous others. We then had the annual statistical data collected by the Aquaculture Branch's extension service with which to compare those taken through the completed questionnaires. Upon interpolation of these data, some anomalies became apparent.

As we already remarked in previous chapters of this report, the main data collected, i.e. those related to fry spawning, fish harvested and feed consumed, have returned considerable "out of standard", with a very high number of fry absent at the time of fish harvest and a feed-consumed/fish-harvested ratio that was far from optimal.

This anomaly seems to us to be mainly due to very high losses of both fry and adult fish by mainly predatory birds (and sometimes amphibians, but for smaller fish concentrated in breeding ponds) and crocodiles, as no particular diseases were found to justify such high 'mortality'. The above-mentioned losses of fry and fish, at the end of the production cycle "weigh" heavily on the ratios between seeding and harvested fish and between harvested fish and feed consumption, negatively affecting the conversion factor ratio (CFR) calculated from these data. In particular, with crocodiles feeding on larger fish (which have therefore consumed the feed for most of the cycle) and with predial larceny obviously

'taking' larger ones as well. The latter is indeed still a widespread social scourge, especially to the detriment of small farmers, some of whom have lost a large part of their production, but large farmers are also not exempt and try to tackle it with expensive security services.

The outlined anomalies, which the final data obviously show, are by their nature unfortunately only evident at the end of the cycle, not allowing the officer and farmer to take intermediate action. This is worsened also by the fact that few farmers keep all the data they need in writing, pond by pond or cycle by cycle or year by year, and when questioned they give data verbally, with estimates made at a glance and kept in mind by memory, while they are busy working; on top of that, many farmers state that they have had many interviews recently and do not see any results, which makes them respond reluctantly and without giving too much weight to the quality of the data provided to interviewer.

Finally, it should be borne in mind that the calculated annual data hardly take into account uncompleted pond cycles, i.e. those that will be harvested the following year or those that mature in the first months of the following year but were seeded the year before.

A 'mortality' hypothesis could be as follows:	
Fry seeded, No.	**abt. 17.000.000**
mortality by birds/amphibians	*30%*
mortality by crocodiles	*20%*
mortality by predial larceny	*30%*
mortality by other causes	*4.5%*
***Total mortality by all causes*	***84.5%***
Fish survived to mortality, No.	**abt. 2.600.000**
Fish harvested, kg	**abt. 870.000**
*Fish harvested, No.	**abt. 2.600.000**
Feed consumed, Kg	**abt. 2.600.000**
CFR	**3**

*The approximate number of harvested fish was derived by multiplying the weight of harvested fish (which is the available data) by the average weight of the fish sold, which was confirmed to be around 330 g each; therefore 1 kg of harvested fish would correspond to approximately 3 fish.

**Total mortality was derived backwards, i.e. assuming a total mortality matching the fry seeded with the fish harvested at the end of the cycle. In the proposed scheme, we have assumed a higher mortality (crocodiles and predial larceny) in the final phase of the grow-out cycle, as this phase would also cause the highest losses in terms of feed 'yield'.

Obviously, these figures are rough estimates, useful only to try to understand how such a high CFR (Conversion Feed Ratio) can be justified.

P.S. The data on fry and harvested fish are from Aquaculture Branch; the data on feed consumed are from domestic producers and customs for imports.

Conclusions

The picture painted by the recently completed phase of survey and analysis of Jamaican aquaculture, reported in the pages of this report, is one of light and shade, but with the light far outweighing the shade, resulting in an overall bright landscape with several positive elements.

Underlying this positivity, of course, is the current market situation, where Tilapia continues to receive attractive quotations, having now reached a price of JMD 650 per pound in March 2022 at the time of this writing, probably due to the scarcity of fish on the domestic market.

Given the average production costs found in our survey, the current margins are very appealing and encouraging further investment in Tilapia farming.

We then saw that there is a very real potential to rapidly increase the Tilapia harvest, as doubling it in the next two years (2023-2024) is not so unrealistic.

In fact, there are at least a couple of farms (DenCon Farms and Longville Fish Farm) that have the scale and internal organisation for rapid increases in production and already harvest on average over 40% of the total crop. If we add to these two farms two other very well organised medium-sized farms, Mr Fray farm and Mr Wilson farm, we arrive at 61% of the 2021 harvest; with a further six small to medium-sized farms we arrive at over 77% of the fish harvested last year. Basically, 10 farms, with the 3-4 largest playing the leading role, are responsible for almost 80% of the national Tilapia encountered in the local market. At this stage of the sector's development, this is a positive factor in planning support measures; it means, for example, that a decisive action focused on these few farms, aimed at rapidly increasing their production, could produce very good results in a very short time, and then acting as a driving force for the remaining farms, which today are semi-amateurish.

Our survey has shown that the production potential, in terms of structures, technical and operational capacities, of the ten above-mentioned farms is much higher than their present production, which is currently limited by some bottlenecks. These are mainly constituted by the sub-optimal availability of fry for seeding, the discontinuity of feed supplies, as well as its price and quality, and finally the very high "mortality" throughout the growth cycle (mortality linked to animal predation and theft). To this list (just well-known and declared by the farmers themselves), which is heavily penalising the fish farming sector, we have to add, as a remark, an insufficient inter-farm collaboration/organisation, which could have already partly solved the problem concerning the fry availability.

So we believe that the keys to a rapid development of Jamaican aquaculture lie in the prompt resolution of the bottlenecks highlighted above.

Finding a way to solve at least one of the bottlenecks to development, the one related to the local availability of quality and affordable feed (and we would add: even on a continuous basis, given the clouds on the horizon of global trade), therefore has its good reasons to be attempted, as is rightly the goal of this assignment.

We then asked ourselves what would be the best way to achieve this, the most feasible in economic terms and the most sustainable in social and environmental terms, and thus also economic in the long term.

We started with one consideration above all others, which is trivial, but precisely because it is trivial, it is often forgotten: you need raw materials to make feed.

If these are not available locally, either now or in the future, for various reasons, feed can only be purchased from abroad (so, leading a strategic sector, in terms of food security, to a dangerous

dependence). In the unfortunate event of this being the only way to provide this fundamental resource, without which intensive and semi-intensive farming cannot work, trade relations with foreign producers would become crucial, import taxes a factor in product price increases, possibly to be avoided, and the need to export goods, preferably to secure, non-fluctuating markets, in order to have the hard currencies needed to pay for foreign supplies, would become a priority necessity. All this, of course, while trying to keep the national trade balance, if not active, at least in equilibrium.

Livestock farming, as an activity requiring feed, therefore finds ideal conditions for development in those countries where at least the majority of the raw materials needed for its production are available on the domestic market, without having to be imported.

This was our aim from the very beginning (as well as getting to know the Jamaican fish farming business to understand its needs and potential): to evaluate the possibility of domestic production of fish feed based on locally available raw materials.

Not unexpectedly, given the evolved status of the national tourism sector and with it the associated hotel and catering industry, Jamaica's agri-food sector is well developed, with well-structured and organised domestic production.

Since a large part of the raw materials can be obtained from this sector, using its by-products, we have found, through research and ad hoc contacts, that there is a potentially large availability of by-products of feed interest. From sugar cane industry by-products (molasses and filtered press-mud), to brewery industry by-products (spent yeast and spent grain), from chicken and pork processing industry (fine ground renderings and flours), to fish and meat processing by-products, from citrus and coconut industry waste, to milling industry by-products (middlings, etc.), from bakery waste, to hospitality industry waste.

All these by-products would need appropriate transport logistics and often minor processing to be transformed into components for the feed industry. Some of these processes are very simple, often involving basic drying (e.g. to reduce brewer's yeast and filtered press-mud, a by-product of molasses processing, to a dry powder); solar dryers could easily serve the purpose, as it is a modest, functional, cheap and sustainable technology (especially given Jamaica's high insolation).

Lastly, we noted the not infrequent presence of irrigated farmland that at first glance seems abandoned. We would like to point out that in Jamaica, maize, cultivated simply and without much technology, could produce 5 tons per hectare in one cycle, and soya 2 tons per hectare, and that, given the climate, there could be two harvests per year.

To conclude, with regard to Tilapia feed, we have:

-a market for fresh local Tilapia, well remunerated and with high margins;

-a small but well-organised farming reality that knows how to perform at both technical and managerial levels, with ample margin for production growth and already with higher than current feed requirements;

-the project of a public hatchery capable of producing millions of fry for local producers, who will certainly need to buy feed;

-a forthcoming intensive shrimp farm, which will also need to buy feed;

-potentially abundant and inexpensive local by-products that, with minimal processing, can be transformed into nutritionally valuable and usable fish feed components;

-a couple of feed mills already operating on the island, which have so far neglected the aquaculture sector due to its lack of economic relevance;

-finally, a couple of farmers/craftsmen, with good mechanical skills and already producing their own feed, of not high quality but sufficient to meet their needs, at laughable costs.

All of the above basically says that the engine parts exist, it's now a matter of figuring out how to successfully assemble them to build a working and efficient machine capable of safely drive the Jamaican feed industry towards its much-needed development.

As for the ornamental fish sector, we have pointed out on several occasions throughout this report that its current state of great decline compared to the glories of the past is essentially and solely due to the definitive disappearance of the export market. Disappearance for which we have succinctly indicated the reasons, linked to serious managerial, organisational and associative shortcomings and not at all to problems of quality and cost of the feed used.
However, a domestic feed business specialising in aquaculture could provide local ornamental fish farmers with all the feed they might need, without any special investment, given that specialist ornamental fish feed, currently only imported, stands at around 11-12 tons/year.

ANNEXES

Annex I - Mission reports
Annex II - List of the stakeholders contacted and interviewed
Annex III - Tilapia Fish Feed Questionnaire form
Annex IV - Ornamental Fish Feed Questionnaire form
Annex V - Photos

Annex I - Mission reports

1st Meeting report of 18/21-02-2022

Name	Activity, Tel. and Email	Date and time:	18/21-02-2022, 14:00 AM
Mrs Avery Smikle	Aquaculture Branch director, 433-0657, avery.smikle@moa.gov.jm	Locality	Spanish town, Aquaculture Branch, Twickenham Park
Mr G. Negroni	Project Team Leader, 281-8051, gigineg@gmail.com		
Mr Andrew Russel	IT specialist, 874-2813, andrew.russel@moa.gov.jm		
Mr Clive Williams	Extension service officer		
Mrs Leanne Bennett	Extension service officer		
Ms Kerrone Fairclough	Extension Service officer		
Mr Keno Garvin	Extension service officer		
Ms Nadia Moneish	Extension service officer		
Total	8		
General objectives	Project planning and presentation		

Discussed points:

1. **Project presentation**: the TL presented the feed project objectives to the Aquaculture Branch staff, the first phase will be to produce the aquaculture situation analysis for fish and ornamental fish producers in Jamaica. The second activity will be the elaboration of the aquaculture feed strategy.
2. **Feed situation**: during the last months (from September) the local Jamaican fish feed availability was erratic, of low quality and with increased prices. Farmers use other animal feed (pig, chicken) or not any feed. It is forecasted that the production cycle will be longer than normal. The use of green water is not yet developed in Jamaica for a number of reasons. A group of Tilapia farmers produce their own feed in Heron areas, it will be interesting to visit them. Some farmers import fish feed.
3. **Feed production**: if there will be the time, the project could try to make some artisanal fish feed production together with the stakeholders, using simple machinery and locally available components. The data about Jamaican fish feed available components will be an interesting project activity. For example brewery waste, rice and wheat bran, rum waste, slaughterhouse residues and fish waste. The components must be of high quality and processed with food safety rules.
4. **Collaboration with the Aquaculture Brach staff and Alveo Team**: the mission is trying to involve as more as possible the Aquaculture Branch staff in the project activities. Mrs Avery Smikle presented Mr Andrew Russel, as IT expert, and five extension officers, which can actively collaborate. They were available to work together with the Alveo team to develop the Jamaican feed analysis and strategy. The collaboration includes field data collection and the search for the available feed components.
5. **Presentation of questionnaires and use**: the validated questionnaires were presented to the staff and discussed for every point. The officer has a deep knowledge of the fish farmers, the questionnaire data will be of high quality. A first questionnaire trial test will be done to have an indication about the system feasibility; the system used is KoBo Toolbox and KoBo Collect. The first test will be in collaboration with the IT specialist to facilitate and validate the work.
6. **Time Scheduling**: this week will be a trial one and next week will be dedicated to data collection. As soon as data will be elaborated, a workshop will be organized to present data to the stakeholders and having the first comments. The visit must include the two Jamaican feed producers and the companies with available components.
7. **Sector association**: if possible the existing fish farming associations must be contacted.

Expectations:

- Data test and software operability this week (21-25 February)
- Data collection (28-02 March)
- Data processing and workshop (05-07 March)
- Draft analysis (15 March)

Next proposed meeting: 23 of March at Aquaculture Branch, Spanish Town at 10.00 AM, test of questionnaire

2nd Meeting report of 23/24-02-2022

Name	**Activity, Tel. and Email**	**Date and time:**	23/24-02-2022, 14:00 AM
Mrs Avery Smikle	Aquaculture Branch director, 433-0657, avery.smikle@moa.gov.jm	**Locality**	Spanish town, Aquaculture Branch, Twickenham Park
Mr G. Negroni	Project Team Leader, 281-8051, gigineg@gmail.com		
Mr Clive Williams	Extension service officer		
Mrs Leanne Bennett	Extension service officer		
Mr Keno Garvin	Extension service officer		
Total	5		
General objectives	Project operation and plan rescheduling		

Discussed points:

1. **Project planning**: the Team Leader was ready to develop the planned activities, perhaps Mr Spence will be available after recovering from the accident he just suffered, for other project activities. Some logistic problems delayed the activities that will be rescheduled due to the many assignments of the extension service officers.
2. **Hardware Aquaculture Branch situation**: The tablets used by the officers had some problems acquiring the free software and their mobile phone is full of data and useless now. It was requested to modify urgently the available hardware to start the work. Mr Russel, the IT responsible was informed. Mr John Thomson (IDB) already produced a short questionnaire with the same software (KoBo Toolbox) with the same extension officers a few months ago, his experience will be helpful.
3. **First questionnaire test**: even in the midst of hardware difficulties, Mrs Leanne Bennett and the Team Leader tested successfully a questionnaire. Some small mistakes were found, some not clear questions were also better defined and corrected.
4. **Collaboration with the Aquaculture Branch staff and Alveo Team**: the mission is trying to involve as more as possible the Aquaculture Branch staff in the project activities. Look like the extension service officers are very busy with previously planned activities and understaffed. This week some of them have to organize a show out of Kingston. Any other activities were changed for next week and the schedule was delayed.
5. **New mission time scheduling**: if there is no availability of the extension service people the mission activities will be delayed from the original forecasted dates. The new proposed scheduling:
   - week 28/02-04/03: 5 visits and questionnaire activities (Tilapia and ornamental fish producers, Tilapia farmers producing their own feed)
   - week 07/03-11/03; 5 visits and questionnaire activities (association, feed producers, fish trader or fish final consumer, available by-products, seller components, shrimp future farm, bivalve molluscs)
   - week 14/03-18/03 stakeholders data workshop, data elaboration
   - week 21/03-25/03 analysis elaboration presentation draft
   - week 28/03-31/03 Final deliverable analysis
6. **Questionnaire administration**: according to time availability, it must be decided how many producers will be interviewed to be a representative part of them (actually, the Aquaculture Branch's will would be to interview them all).

Expectations:

- Visit to be organized for two weeks with the consultant
- Data to be inputted
- Data processing and workshop (March)
- Draft and final Situation Analysis Report (March)

Next proposed meeting:

3rd Meeting report of 23/24-02-2022

Name	**Activity, Tel. and Email**	**Date and time:**	23/24-02-2022, 14:00 AM
Mrs Avery Smikle	Aquaculture Branch director, 433-0657, avery.smikle@moa.gov.jm	**Locality**	Heron Hill, Mr Fredrik Lyn
Mr G. Negroni	Project Team Leader, 281-8051, gigineg@gmail.com		

Situation Analysis Report

Mr Fredrick Lyn	Farm owner, feed producer 876-382-4854, 891-7375	
Total	3	
General objectives	Fish farm feed production	

Discussed points:

1. **Farm description**: the farm is located at Heron Hill and is around 20 acres surface, producing some vegetables (10 acres), goat, sheep, goose, and Tilapia. Mr Fredrick Lyn is skilled in mechanical engineering and has a large workshop with all the needed equipment. He has 6 ponds of 200 x 200 feet surface (60.96 x 60.96 = 3,716 m2). The total production is estimated at 15,000 Kg per year, fish are sold at 4 pounds weight (1.81 Kg) and 4,000 fingerlings are put in every pond. Each mature fish of 4 pounds is sold at 700 JMD to the Chinese community. Data to be validated, especially fish production data.
2. **Hardware for feed production**: he already has a hammer mill, a large mixer, a pellet machine. He produces all his feed needs for his animals (sheep, goose, and fish). The machinery is in working status and has an approx. capacity of 5 Ton / Day or more (to be confirmed). The hardware needs to be refined with small adaptations, particularly for the size of the flower (hammer mill), the lack of a sieve of different sizes, and a drier. Moreover, there is not an appropriate space dedicated for feed production and a warehouse for finished feed and feed components.
3. **Feed component and fish diet**: actually, the main feed components used are: chicken rendering, coconut waste, molasses, corn trash. He encounters problems with component availability.
   According to the opinion of Mr Lyn, the list of available components is the following:

By-products	Available at (and problems)	Approx. costs and problems*
Chicken (pork) rendering	Nutramix plant, already treated	300 JMD per sac (25 Kg)
Fishery by-product	J & B and Rain Forest processing factories (perishability)	Transport costs
Wheat bran	At flower mills (low quality)	Competition in collecting, transport costs
Molasses	Imported now	30.000 JMD per ton
Beer hops	Beer factories	Competition in collecting, transport costs
Corn trash	Mill factory	Transport costs
Restaurant waste	Tourist complex, restaurant, food chain (Mac Donald, KFC, etc.) (perishability)	Transport costs
Biscuit rest	Biscuit factories	Competition in collecting, transport costs
Coconut by-products	Two Coconut water and oil factories	Transport costs
Used fried vegetable oil	Food chain (low nutritional value: unsaturated fatty acid)	Transport costs
Fish rest and fish waste	Landing beaches, ports, Fishery Coop	Logistic (scattered along the coastline)
Neem/Moringa fruit & leaves	Many trees present on the farm	Collecting costs

   * To be validated

   There is not any component analysis and their availability is sometimes erratic. Anyway, Mr Lyn can produce all its fish and other animal feed for 8 years. The time of fish maturation is two months more than the imported feed. Also, the Feed conversion ratio (FCR) is more than imported feed (estimation 3 Kg of local feed for 1 fish of 4 pounds/1.8 Kg) (1 pound = 0.45 Kg).
4. **Feed ratio and business calculation**: meanwhile the cost of a sack of fish grow out is around 30 USD (local or imported at high) the production cost for Mr Lyn is about 3 USD per sack (1 sack = 25 Kg). The calculation of Mr Lyn must be refined as it does not include: the structure/equipment maintenance, structure/equipment depreciation, and manpower costs. It is interesting to consider that the Jamaican fish feed availability is erratic and the quality is often questionable and difficult to control. Finally, the production is 12 Ton per feed per year according to Mr Lyn's declaration.
5. **Designing a collaboration with Mr Lyn**: the mission is trying to understand if a person like Mr Lyn can be a resource for Jamaica fish farmers. Today we understood that Mr Lyn can produce more if supported by a business structure that provides him the available by-product components in the requested quantity.

Expectations: advice and organization

- better feed processing technology
- component availability and logistic
- fish farm profitability
- feed production

Next proposed meeting: not discussed

4th Meeting report of 28-02-2022

Name	**Activity, Tel. and Email**	**Date and time:**	28-02-2022, 12:00 AM
Hannett and Jo	Informal sellers, Spanish Town, Twickenham Park live fish market	**Locality**	
Mr Robert Lu	Ornamental fish farmer 876-864-3747		
Mr Herah Singh	Sugar cane processing 361-3757		
Mr G. Negroni	Project Team Leader		
Mr Clive Williams	Extension officer, clive.williams@moa.gov.jm		
Total	6		
General objectives	Stakeholder interview and project planning		

Discussed points:

1. **Spanish Town Twickenham Park live fish market**: the fish market is located a few hundred meters from the headquarters of Aquaculture Branch, on the main road. There are 18 tanks to sell live Tilapia fish, and only 7 are active now. The market is informal and not regulated at the moment; it is the largest and well known national live fish market in the island.
   Food safety: there is no any food safety standard. There are domestic animals and wild birds around and inside, hygiene is scarce. The active tanks use water from the canal and the market discharge and wastewater go to the same canal. Some fish are gutted on the place and the rest thrown into the canal. No ice, no cold store and no packaging material available, some recycled newspaper. The market would need to be refurbished.
   Origin of fish and business: the trader goes to the Tilapia farmers' gate to buy the red Tilapia of any size, with a water tank. The farm gate red Tilapia price goes from 380 to 450 JMD, according to many factors as the fish availability and size. The most sold fish are two per pound and one per pound, their selling price is between 550 to 600 JMD. Holiday/Friday and Saturday are the best selling days.
   The market dynamic: it was told that a seller can sell 150 pounds of fish on average per week, the seller demands more fish as there are supply problems for different reasons. The market clients complain about the actual high Tilapia prices. There is no cooking activity in the market. The estimated daily market selling quantity is around 200 pond of red Tilapia on average. The market stakeholders complain about the low governmental activity.
2. **Mr Robert Lu, ornamental fish farmer**: Mr Lu is a part-time ornamental fish farmer already retired from another job. He has 5 acres of ponds and farm cichlids only, not far from the Aquaculture Branch office. He buys approx. 10 bags (25 Kg) of Zeigler feed (imported from US by Nadwearl, Manchester) per year at 20 USD/Kg. He sells the fish locally and exports through the Competitiveness Company (TTC).
3. **Mr Herah Singh, Raw Sugar Manufacture**: the interview was conducted online. Mr Singh is a senior sugar cane processing specialist, he works for the Sugar Company a raw sugar manufacturer that produces crystal raw sugar. The factory's sugar cane by-products are the following:
   - bagasse, used for fuel in the plant
   - final molasses, sold through Caribbean Molasses (to be visited in Kingston)
   - press-mud, used as fertilizer in the sugar cane fields (2% sugar, phosphates, sulphates and calcium), already experimentally used in Tilapia farming

   The molasses is given to distilleries that have 'dunder' as residues.
   The company produces 10,000 Ton of molasses (around 4% of the cane)
4. **Team Leader timetable organization**: it was decided that two Aquaculture Branch extension officers will work full time for the Team Leader to make 50% of the farmer's interviews and they will accompany him in the field for the next weeks. The one that will be not busy with the Team Leader will make other interviews and visits.

Expectations:

- Data validation of the two interviews
- Complete the planned timetable for interviews and visits

Next proposed meeting:

Situation Analysis Report

5th Meeting Report of 01-03-2022

Name	Activity, Tel. and Email	Date and time:	01-03-2022, 08:00 AM
Miss Leanne Bennett	Aquaculture Branch extension officer	**Locality**	Run Hill and NFA
Mr G. Negroni	Project Team Leader		
Miss Fenicia Morgan	Mustard Seed Farm (Less fortunate person Foundation) manager, Run Hill		
Mrs Ana Dalas	Ana Dalas Farm owner, Run Hill		
Mr Badal	Badal Farm owner, Run Hill		
Dr Gavin Bellamy	National Fisheries Authority CEO		
Total	6		
General objectives	Stakeholder interview and feed import regulation		

Discussed points:

1. **Mustard Seed Farm**: the fish farm is managed by the Less Fortunate Person Foundation inside a large compound where the Foundation assists people to live. There are 5 barns for eggs chicken and 1 for broilers. The two ponds are at the centre of the farm, their size is 1,600 m2 (40 X 40) each (tot 3.200 m2). The water comes from an irrigation channel that can supply 42 M3 per hour (one pond is filled in two days). They produce two crops per year for a total of 1,816 Kg of red Tilapia per year. One pond was empty waiting for the National hatchery fingerling, while the other pond was already seeded last month. The workers cleaned the macro-algae from the pond in production. In one year, 180 bags of Hi-Pro Tilapia (28% protein) feed are consumed, for a total of 4,500 Kg. The ponds are seeded with 1 gr Jamaica red Tilapia fingerling, 12,000 per pond. The adult fish is sold at 230 gr. Predial larceny is frequent, while diseases are not accused. Green water is used only in the fingerling stage, less later. Water analysis is not available.
2. **Ana Dalas Farm**: the farm has 4 ponds of 2,100 m2 each, with 2 in use. Water needs to be pumped inside the ponds by a 1.5 HP pump, one month filling time; the water comes from the irrigation NWC network. The production cycle is a 7-month cycle, 6,500 fingerlings per pond are purchased from the Aquaculture Branch National Hatchery. 1 ton of feed is used per year for the two ponds; the feed was paid 114 JMD/Kg in August. The farm has a large feed reserve to complete the actual cycle. In 2018, the feed was of better quality and the production cycle only lasted 4 months. Mrs Dalas is economically satisfied, she will use the other two ponds soon; there is no feed eating nor green water control. Water analysis and pond surface were not available. Mrs Dalas knows some person that already imported appropriate machinery for fish feed production, she will contact the Aquaculture Branch officer soon.
3. **Badal Farm**: the farm is one of the largest in Jamaica. Mr Badal has a sister with another fish farm, Mrs Tresh Badal. The farm is composed of 25 ponds, the water comes from the irrigation network, sometimes there are water availability problems. The farm has several small pumps (2-5 HP) and one larger pump (5,000 M3/hour; 7 inches pipe diameter). This large pump fills one pond in 12/18 hours if the water is available. Now, with the actual feed, the cycle takes around 7 months, before 4 months only. The farm employs 3 full-time workers and 7 occasional during the harvest. 25,000 fingerling are seeded per pond. The sale price of the harvested red Tilapia is 880 JMD/Kg. The farm buys the fingerling from The Aquaculture Branch National Hatchery and some private hatcheries, and sells abt. 3,629 Kg of adult fish per year per tank. The farm spends 3,500 JMD per bag of on-growing Hi-Pro Tilapia (28% protein) feed. Estimated pond surface is abt. 1,000 m2 (to be validated), depth from 1.2 to 1.8 m, water level 1 m average. The owner is available to buy imported feed in large quantities, but he needs the services to do it.
4. **Mr G. Bellamy about feed import**: Mr Bellamy has a long experience as responsible for the feed import at the National Fisheries Authority. To import feed or feed components, the following operations are required: A) apply to the Veterinary Service Division the permit to import fish; the origin certificate and the name of the producer are required to complete the risk assessment; this permit has 3-month validity and is single-use; (this matter depends on the "Animal disease importation act"); B) pay the custom charge, which now is 22% of the value of the feed (this matter depends from the "Customs Act").
   NFA now is negotiating to reduce 5% of the customs tax with the government.
   Finally, some points about the strategy to produce some feed components were discussed. In Jamaica, the limited land cannot be properly used to produce feed components (corn and soy for example). New modern technologies can be used to produce feed components such as micro and macro-algae, single-cell protein, and insect production. Of course, the whole matter must be appropriately considered.

Expectations:

- Data validation of the three interviews
- Feed taxation to be considered and other alternatives

Next proposed meeting:

6th Meeting Report of 03/04-03-2022

Name	**Activity, Tel. and Email**	**Date and time:**	03/04-03-2022, 08:00 AM
Mrs Leanne Bennett Mr Keno Garvin	Aquaculture Branch extension officers	**Locality**	Spanish Town and NFA head office
Mr G. Negroni	Project Team Leader		
Mrs Avery Smikle	Aquaculture Branch director		
Mr Derrick Spence	Alveo consultant		
Mr Albert Deily	NGO LIFE director, 876-330-3452		
Mr Damion Newman	Newman Fish Farm owner		
	National Fisheries Authority		
Total	7		
General objectives	Stakeholder interview and feed import regulation		

Discussed points:

1. **Newman Fish Farm**: on the 3rd of March there was a field trip to St. Elizabeth Parish with extension officer Mrs Leanne Bennett. The only farm visited was Mr Newman's, the others were not available. The farm includes 4 0.5 acre ponds and 5 0.25 acre ponds for a total of 1.5 acres. It features an integrated farm with 50 piglets and about 20 ducks. A river with a flow rate of one cubic meter per second (approximately) flows at the edge of the farm. Pumping is done with a 6-inch pump. 6 ponds are currently stocked with Jamaica red Tilapia. The feed currently used is Nutramix (28% protein, sinking) and BioMar (36% protein, sinking). The BioMar feed was purchased from the neighbouring company DenCon, a new batch of BioMar feed was purchased these days for 5,500 JD per bag (25.5 Kg). The farm stocks an average of 5,500 fry of 1 gr of red Tilapia per pond (0.25 Acres). Last year, 1,000 pounds (455 kg) of fish (230 g average weight) were produced, consuming 2,000 kg of feed. The farm has a small store with 2 m3 concrete containers to sell its own live fish and the fish bought from the neighbours, the fish is sold at 450 JMD per pound. Half of the ponds use green water system, especially the ones near the pigsty.
2. **Mr Derrick Spence**: following the accident that occurred to Mr Spence, due to his unavailability, a meeting was held to organize the interviews for the Tilapia farmers. The need to use a presentation and appointment system to be received by the farmers was also emphasized.
3. **Aquaculture Branch**: The consultant went to the Aquaculture Branch to obtain the phone numbers of the Tilapia and ornamental fish farmers. On this occasion, the project proposal was confirmed to concentrate the interviews on a representative number of farmers to be established jointly with the Aquaculture Branch, which in turn confirmed the collaboration of its extension service. So far, after two weeks of work, only 4 questionnaires have been completed with the two extension officers mobilized full time.
4. **Mr Albert Deily**: Mr Deily, director of LIFE NgO, showed great interest in feed production for LIFE projects. The various feed technologies and the possibility of using Jamaican by-products have been illustrated. LIFE deals with community groups, aquaponic, rainwater harvesting and small-scale agriculture. Mr Deily, who works at the Ministry of Finance, made himself available for further information and visits.
5. **NFA**: a cover letter was delivered by the National Fisheries Authority CEO for the consultant's mission to farmers and other stakeholders.

Expectations:

- Data validation of the interview
- Interview organisation

Next proposed meeting:

7th Meeting Report of 10/11-03-2022

Name	**Activity, Tel. and Email**	**Date and time:**	10/11-03-2022, 09:00 AM
Mrs Avery Smikle	Aquaculture Branch director	**Locality**	Kingston
Mr Gianluigi Negroni	Project Team Leader		

Situation Analysis Report

Mr Christopher Gentle	Caribbean Molasses vice-director, 968-4455	
Mr Gordon Carck	Worthy Park Estate manager, 399-4350, St. Catherine	
Mrs Nataly Stephens	Worthy Park Estate assistant, 522-0638, n.stephens@worthyparkestate.com	
Mr Eisten Mc Lean	Heineken sustainability manager, 551-1781/922-2606, 241 Spanish Town Road St. Angel, eisten.mclean@heineken.com	
Total	6	
General objectives	Mapping the fish feed available components	

Discussed points:

1. **Sugar cane Industry Worthy Park Estate**: The Caribbean Molasses imports fermentation grade molasses from Latin America, being the locally produced insufficient for the Jamaican distilling industry. The Worthy Park Estate owns 9,000 acres for the sugar industry and can sell molasses locally for a minimum of one ton at a time. In Jamaica, there is another company that deals in molasses: the Pan Caribbean Sugar Company. The molasses for animal feed is called feed grade molasses and costs USD 220 per ton. In addition to molasses, the sugar industry produces a by-product, called "filtered press-mud", which has a protein content of 18%, as well as phosphorus and potassium, and is used as a fertiliser. Experiments have been carried out with carp, which can be fed a diet containing up to 30% press-mud. Local rum distilleries also have a liquid waste called 'dunder' with high BOD and COD that could be concentrated and used in animal feed. Finally, there are the ash from burning sugarcane bagasse, which, when analysed, could provide some minerals in the diet, and the sugarcane leaves, which could be used after appropriate processing.
2. **Heineken Beer Industry**: The industry produces 3,500 ton year of spent grain that is actually adsorbed by the beef industry; its sale price is 1,500 JMD/Ton. In addition, there are 37 tons/year of cassava waste. Finally, there is the availability of fresh yeast in pasty form which currently goes into the company's purification plant. We will be informed of the composition and quantities available.
3. **B & D Trawlers**: the company fish and process fish. They have 2 tons a week lobster head and waste. In Jamaica there are 300 Ton of conch meat, 30 are meat waste. There are other three commercial fish processing factories, two owned by Rainforest Caribbean (Water Wheel and Rainforest 2, respectively in Westmoreland and Montego Bay) and the last one by Cools Seafood (particularly for fish fillet). Alligator Foundation is doing studies on sea cucumber farming.

Expectations:

- Receive more detailed information on the available by-products

Next proposed meeting:

8th Meeting Report of 14-03-2022

Name	**Activity, Tel. and Email**	**Date and time:**	14-03-2022, 09:00 AM
Mr G. Negroni	Project Team Leader	**Locality**	Spanish Town
Mrs Dennie O'Connor	Best Dressed Feed Mill nutritionist, Old Harbour, mob. 876-383-5129, TOConnor-Dennie@jabgl.com		
Total	2		
General objectives			

Discussed points: data collection on fish feed

After a quick presentation of the Project's goals, the topics covered in the meeting in brief were:

1. **Feed Legislation**: the Jamaican Bureau of Standard control the feed quality and issue appropriate legislation. Old legislation: Fertilizers and Feeding Stuffs Act, 1942 (revised in 1973).
2. **Best Dressed Feed Mill activities**: the company is the only mill that produces fish feed, under its brand Hi-Pro. The mainly produced type is the Tilapia 28 Super 10 (pellet), the others must be ordered in advance. In the last months, the mill proposed a new product, the Pro-Pak®; it is a protein concentrate and a cost-efficient replacement for fishmeal in poultry feeds. It is a combination of high-quality marine, animal by-products and vegetable proteins (and yeast) formulated to produce the same response as a high-quality 60-65% protein fish meal, including all essential amino acids. It was proposed as a substitute for fish meal

(until 50%), but had not succeeded in the farmer's requests.
The total fish feed produced at the mill was (Ton):
- 2021: 1,896 (1,664 of the Tilapia 28 Pellet type and 232 of the other Tilapia feed types).
- 2020: 1,575
- 2019: 1,554
- 2022: prevision goes from 2,200 to 2,500 Ton of fish feed.

The feed components are: soybean meal, grounded yellow corn, processed grain (wheat middlings and brewery waste), fish meal and premix. All feed use the same components at different percentage to meet the fish diet in the different stages of production. The feed must be ordered in advance by the farmer. Before COVID, all types were available, until now only the 9006-2 Tilapia 28 Super 10 (pellet) is available. The extruded fish feed could be imported in case of larger demand. The company has a low interest in fish feed for its small market. After last hurricane, the company restarted to sell Manhaiden fish meal (2,478 USD Ton on the international markets, plus company revenue).

3. **The import of feed components**: the company imports all feed components from abroad, the tax is 20% and there are 10% of other costs to arrive at mill gate. The main imported feed components are: soybean meal, gluten corn, processed grains, and fish meal. The premix is produced in Jamaica with imported components. Best Dressed Feed Mill imported 160,000 Ton of corn and 62,000 Ton of soy meal in 2021.
4. **Fish feed logistics and distribution**: the feed is delivered at the warehouse in Spanish Town. Only large quantities are delivered to the farm's gate. There is a network of small agriculture shops that sell Hi-Pro fish feed bags in the Jamaica countryside. There is a Hi-Pro farmer service directed by Mr Dean Patterson.
5. **Flour mills**: there are two industrial flour mills: Jamaica Grain and Jamaica Flour Mills Limited (JFM). They sell grain middlings at 33,000 JMD per ton.
6. **Best Dressed Feed Mill visit**: the visit introduced the mill, the mixer, the pellet, and bag machinery.
7. **Solutions**: Mrs O'Connor would encourage the use of local components to cut the import taxes but quality must be high. She already asked for bakery leftover but the price was higher than corn (400 USD/Ton).

Expectations:

- Description of the fish feed value chain

Next proposed meeting: on line

9th Meeting Report of 21/22-03-2022

Name	**Activity, Tel. and Email**	**Date and time:**	21/22-03-2022
Mr G. Negroni	Project Team Leader	**Locality**	Ministry of Agriculture and Fisheries (MAF)
Dr Martin Simone	Veterinary Division, 977-2489/92		
Mrs Angela Patterson	MAF spokesman		
Mr Lance MacDonalds	Fisheries Division officer		
Lt Cmdr George Overton	National Fisheries Authority board		
Dr Gavin Bellamy	NFA CEO		
Dr Crispim Moreira	FAO representative for Jamaica		
Hon Pearnel Charles Jr, MP	Minister of Agriculture & Fishery		
Mr Stephen Smikle	Marine Branch director, NFA		
Mr Bunting	Longville Fish Farm owner		
Total	10		
General objectives	Information		

Discussed points: NFA activities and Jamaica import of feed

1. **Fish feed, Veterinary Division**: visit and request for the list and quantity of imported feed and feed component were not available as it must be requested to the Information Unit. Immediately a request was done but the Information Unit answered they have 30 days to answer the request. An additional request was done to speed up and for informal information but without result.
2. **International Year of the Artisanal Fishery & Aquaculture (IYAFA) and the marketing of tilapia**: the meeting was about the activities of the National Fisheries Authority, the Ministry of Agriculture and Fisheries related to the International Year of Artisanal Fishery & Aquaculture (IYAFA). FAO presented the activities on IYAFA for this year. The Team Leader presented the mission activities to the Honorable

Minister and the board of the National Fisheries Authority. A farmer provided an example of Jamaican farmed Tilapia cooked in Jamaica style.
Expectations:
• Data collection and IYAFA presentation and mission activities
Next proposed meeting: ASAP to collect information

10th Meeting Report of 23-03-2022

Name	**Activity, Tel. and Email**	**Date and time:**	23-03-2022, 07:00 AM
Mrs Selena Ledgister	World Bank PPCR manager	**Locality**	St. Elizabeth
Mr Heir Johnson	Nadwearl Ltd owner		
Mr Hall Bisel	Nadwearl Ltd assistant		
Mrs Patsy Williams	DenCon Farm site manager		
Mr Harshel Cyrus	DenCon Farm owner		
Mr Grandville Williams	DenCon Farm operative manager		
Mr Robin Hall	Ornamental Fish Farm owner		
Mr G. Negroni	Project Team Leader		
Total	8		
General objectives	HI-PRO stakeholder presentation and visions		

Discussed points:

8. **<u>Nadwearl Ltd, ornamental fish shop (& feed)</u>**: several phone calls were anticipated and a presentation NFA letter was also shown to Nadwearl, but there were no answers or possibility to talk to any responsible. Finally, a visit was decided and it was possible to discuss vis-à-vis the real problems of importing feed for ornamental fish (in fact, Nadwearl buys all of its fish feed in the USA from Zeigler and Spectrum; the latter for koy stick). The end cost of ornamental fish feed includes 20% tax and 50% transport and logistic costs. The company makes only large volume sell and the largest ornamental fish companies buy here, as The Guardsman and The Competitiveness (but also the main pet shops around Jamaica). In case there will be a local producer of ornamental fish feed, Mr Johnson will be very happy to buy from the Jamaican producer. The ornamental fish market and hatchery markets needs were exposed to Mr Johnson for the future, this related to the future hatchery production. The total import value in 2021 was around 137,000 USD, divided in 3 orders; the total includes other materials and transport costs (1 container from Miami is 4,000 USD).
9. **<u>DenCon Fish Farm</u>**: the manager, together with the operation specialist Mr Grandville Williams, presented to us all the farm activities: hatchery, nursery, and two grow-out phases. Moreover, two feed containers were received and we witnessed the quality control. The new modern processing fish farm was also presented, it will be ready to work shortly. Only 100 acres are in production and the next step will include using all the remaining available ponds areas; a new bulldozer is available to reshape and clean the new ponds, the line is placed above the ponds against the birds. Security was a concern and modern sensors were installed all around the farm to avoid predial larceny; security guard is present all the time, as there were some problems in the past. 35,000 fry days (except Sunday) are collected from the 8 spawning ponds. Black Tilapia are preferred by the local rastafari customer, they grow faster than the white and red variety. The Team Leader assisted in a transfer of fish, the transferred fish was a mixture of white, red, and black Tilapia. There is a mass selection genetic program for the local brood stock, it originated from the Jamaican available brood stock from Aquaculture Division hatchery. All feed used is imported, mainly from SouthFresh Feeds, an Alabama company. The SouthFresh 28 % protein type costs about 150 JMD/Kg, it is imported in large bags inside the container, every bag has a sample to be analysed. The hatchery and grow-out system is divided into 4 phases: 1) the brood stock selection / fray / fingerling phase (30 days; mortality abt. 50%); 2) the juvenile phase (up to 50 gr; mortality abt. 20%); 3) the first grow-out phase (up to 150 gr; mortality abt. 10%); 4) finally, the grow-out phase (up to 350 gr; mortality abt. 5%). On mortality rates, there are no scientific data, but rough averages. The brood stock is grown in 1/4 acre pond, while the spawning takes place in one-acre pond with a 70/30 female/male percentage; fry are seined daily.
10. **<u>Robin Hall Ornamental Fish Farm</u>**: after making a phone meeting, it was not possible to visit the farm.

Expectations:

•

Next proposed meeting:

Annex II - List of the stakeholders contacted and interviewed

Name/Position	Institution/Entreprise location	Tel.	E-mail
Private sector			
Mr Kyle Tofte CEO	Ryco ltd, St. Jago Road, Clarendon	876-822-2310, 987-1891	rycoja@yahoo.com
Mr Christopher Gentles Vice-director	Caribbean Molasses, 5 Trevennon Park Road, Kingston 5	876-968-4455	
	Pan Caribbean Sugar Company	968-4455	
Mr Gordon Clarck Director	Worthy Park Estate, St. Catherine	399-4350	
Mr Herah Singh Sugarcane proces. specialist	"	361-3757	
Nathalie Stephen Distiller account officer	"	522-0638	n.stephens@worthyparkestate.com
Mr Sheldon Sharpe Manager	Heineken	552-1781/922-2606	stephen.sharpe@heineken.com
Mr Eisten Mc Lean Sustainable manger	Heineken	552-1781/922-2606	eisten.mclean@heineken.com
Mr Winston Thomas	Nutramix Group, Newport Mills	922-2606	winston.thomas@mycbgroup.com
Mr Hans Muller	"	"	hans.muller@mycbgroup.com
Mr John Francis, Director	B & D Traweller	922-2334, 771-7967	
Mr Maxwell Jardim Business development	Rainforest Caribbean Group	(876) 520-7170	benjardim@rainforestcaribbean.com
Mr Marvin Keller Officer	"	"	mkellier@rainforestcaribbean.com
Mrs Donna Baychue	"	"	dbaychue@rainforestcaribbean.com
Mr Jaime Ogilvie Vice-president	Best dressed Chicken Hi-Pro	"	
Mr Dayan Patterson Feed Business develop.nt	"	"	
Mr Kirk Pennant Technical advisor	"	"	
Dr D. O'Connor Nutritionist	"	383-5129	TOConnor-Dennie@jabgl.com
Mr H. Collins	Hi-Pro Feed extension manager		
Mr Thomas Newell	WB Consultant	371-1981	

Mr Omar Newell CEO	Rerum Trading LTD, Feed importer	388-1668, 612-3381	
Mr Johnson, Owner, Mrs Hiaed, Accountant	Nadwearl, Mandaville, Manchester	962-6332/6510	nadwearlagri@hotmail.com
Exotic Birds Pet	Montego Bay	952-0281	
Our Pet Pal	110 Constant Spring Road, Kingston	969-5184	
Hobby Hut Pet Shop	151 Old Hope road, Kingston	702-2490	
Mr Albert Deily, Director	NGO LIFE	330-3452	
Public sector			
Mrs Avery Smikle Director Aquaculture Branch	Director Aq Branch	433-0657	avery.smikle@moa.gov.jm
Dr Alwin Watson Director	Veterinary Division	977-2489/92/95	alwin.watson@moa.gov.jm
Dr Simone Martin Feed activities	Veterinary Division	"	simone.martin@moa.gov.jm
Dr Suzan Mc Lennon	"	"	
Mrs Noreen Dennis Senior librarian	Agriculture Library	967-1526	research@nlj.gov.jm
Mr Richard Wendall Officer	Bureau of standard, Winchester Road, Kingston 10	632-4275/618-1534	
Director of Documentation, Information & Access Service – DIAS		927-1731 ext 2035	ati@moa.gov.jm
Mr Winsom Bruce	Statistical Institute of Jamaica	630-1600	wbruce@statinya.gov.jm
Contacted Tilapia Farmers			
Mr Fredrick Lyn Owner	St. Catherine, feed producer	876-382-4854 891-7375	
Mr Hurshell Sirius Owner	DenCon (ex Algix), St Elizabeth	412-5109	hurshell.sirius@algixjamaica.com
Mrs Patsy Williams Manager	"	913-9291 830-3474	patsy.williams@algixjamaica.com
Mr Phillip Bunting Owner	St. Cathrine	876-383-6513 322-9001	
Mr Noel Wilson Owner	Hill Run	876-318-3807 318-3807	
Mr Christopher Fray Owner	St. Cathrine	876-890-3171 503-3525	
Mr Garfield Christie, Owner	Hill Run	876-315-2197	
Mr Ramon Badal	Hill Run	876-891-4617	

Owner		610-7676	
Mr Howard Hill Owner	Hill Run	538-9372 / 990-1412 / 990-1414	
Mr Cleon Mashall, Owner	Hill Run	876-468-3333	
Mr Rocco Binns, Owner	Hill Run	876-328-2684	
Mr Damion Newman, Owner	St. Elizabeth	876-435-5333	
Mustard Seed NGO	St. Cathrine	876-506-0148	
Mrs Anna Dallas, Owner	Run Hill	876-793-7204	
Mr Alvin Murray, Owner	Hanover	876-829-4537	
Mr Thomas Guyah Owner	St. Cathrine	370-8778 788-9500	sundar.guyah@gmail.com
Contacted Ornamental fish farmers			
The Guardsman Group	Kingston, Hope Garden	841 4142	
The Competitiviness Company Ltd	Kingston, Old Hope Road	853 5544	
Mr Lance Mc Donald, Owner	Kingston, Mona	876 545 0106	
Mr Thomas Guyah Owner	St. Cathrine	370-8778 788-9500	sundar.guyah@gmail.com
Mr Jermaine McFarlane Owner	Kingston	876 536 2295	
Mr Christopher Stephenson Owner	Kingston	8763 46 8017	
Mrs Marlene Tulloch, Owner	St. Andrew	876 542 8392	
Mr Robert Yap Foo, Owner	St. Cathrine	876 997 4771	
Mr Orville Brown, Owner	St. Cathrine	876 817 9858	
Mr Wilton Nesbeth, Owner	St. Thomas	876 468 9959	
Mr Garth Johnston, Owner	St. Thomas	876 543 4436	
Mr Runique Edwards, Owner	Trewlany	876 457 9634	
Mr Greg Henry, Owner	St. Andrew	853 5544	

Annex III - Tilapia Fish Feed Questionnaire form

Tilapia Fish Feed Jamaica

Interview

Enter a date:

yyyy-mm-dd

Interview by:

Farm

Farm name:

Farm address:

Farm address (Parish):

- ◯ St. Catherine
- ◯ Clarendon
- ◯ Manchester
- ◯ St. Elizabeth
- ◯ Westmoreland
- ◯ Hanover
- ◯ St. James
- ◯ Trelawny
- ◯ St. Ann
- ◯ St. Mary
- ◯ Portland
- ◯ St. Thomas
- ◯ Kingston & St. Andrew

Farm code (Fishery Division ID Number):

Farm licenses (if the case):

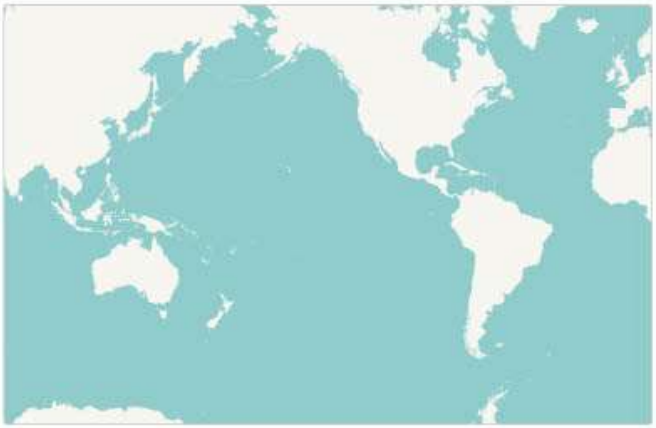
Record your current location (get the GPS position at the farm entrance):

latitude (x.y °)

longitude (x.y °)

altitude (m)

accuracy (m)



1. DESCRIBE YOUR FISH PRODUCTION CYCLE

- ◯ Hatchery and nursery
- ◯ Grow-out
- ◯ Complete cycle, from hatchery to grow-out

2. In case your farm includes hatchery & nursery

What is the goal?

- ◯ only for internal use (grow-out)
- ◯ only for fry/fingerling sales
- ◯ both, for internal use (grow-out) and fry/fingerling sales

Hormone use:

- ◯ yes
- ◯ no
- ◯ other

Fry/fingerlings produced per year:	No.	if sold, at what unit price (JMD)?
o. niloticus		
o. mossambicus		

hybrid		
other species		

Production time (average number of months from spawning to sale or grow-out):
Average size of fry/fingerlings for sale or for stocking into grow-out ponds (grams):
Percentage of harvested fry/fingerlings going to grow-out ponds (mortality):

3. In case your farm includes grow-out

What is the fry/advanced-fry/fingerling origin?	quantity %
internal production	
purchased from external source	

In case of purchased fry/advanced-fry/fingerlings, indicate for each strain:	other species name	supplier name	No.	approx. unit cost (JMD)
o. niloticus				
o. mossambicus				
hybrid				
other species				

Adult fish sale:	total Kg produced per year	product average size (grams)	sale price (JMD/kg)
live fish			
whole fish			

processed			
fillets			

Type of sale:	**quantity %**
to end consumer (private)	
to intermediate consumer (restaurant, bar, food kiosk)	
to retailers (fish shop, supermarket)	
to higglers	
to wholesalers	
Production time (average number of months from grow-out to sale):	
Percentage of fry/fingerlings going to adult fish sale (mortality):	

4. Site description

Buildings:	**No.**	**total square meters**
for administrative use		
for production use		
for laboratory use		
for storage use		
for other use		

Power supply:
- ◯ public grid
- ◯ generator
- ◯ both

Accessibility:
- ◯ no road
- ◯ dirt road
- ◯ paved road

Spawning system (if present):	type	No.	surface (m2)	volume (m3)	stocking density (No. x m2)
ponds	☐ earthen ☐ liner ☐ concrete ☐ net				
tanks	☐ earthen ☐ liner ☐ concrete ☐ net				
hapa	☐ earthen ☐ liner ☐ concrete ☐ net				
other	☐ earthen ☐ liner ☐ concrete ☐ net				

Incubation system (if present):	No.
jars	
other	

none					
Nursery fry system (if present):	type	No.	surface (m2)	volume (m3)	stocking density (No. x m2)
ponds	☐ earthen ☐ liner ☐ concrete ☐ net				
tanks	☐ earthen ☐ liner ☐ concrete ☐ net				
hapa	☐ earthen ☐ liner ☐ concrete ☐ net				
other	☐ earthen ☐ liner ☐ concrete ☐ net				
Grow-out system (if present):	type	No.	tank overall volume / pond overall surface	stocking density (No. x m2)	No. of species raised per container
tanks	☐ plastic ☐ cement ☐ earthen ☐ autoconstructed				

ponds	☐ plastic ☐ cement ☐ earthen ☐ autoconstructed				

Unused structures (if present):	**No.**	**surface (m2), when applicable**
buildings		
ponds		
tanks		
boreholes		
water canals		
other		

Soil composition:

- ☐ low permeability (clayey)
- ☐ medium permeability (mixed)
- ☐ high permeability (sandy)
- ☐ hard to dig
- ☐ easy to dig

Water source:	**availability**	**mc x hour**	**mc used x week**
borehole	◯ year-round ◯ seasonally		
river / stream	◯ year-round ◯ seasonally		
dam	◯ year-round ◯ seasonally		
other	◯ year-round ◯ seasonally		

Water quality (if and where known):	temp. min. (°C)	temp. max. (°C)	pH	salinity (gr/kg)	hardness (°F)	oxygen (mg/L)	coliforms
parameters							◯ yes ◯ no

Water effluent treatment / depuration:

◯ present
◯ not present

Hygiene:	washing	disinfection	chemical / detergent used	frequency
equipment	◯ yes ◯ no	◯ yes ◯ no		
tanks / containers	◯ yes ◯ no	◯ yes ◯ no		
areas / floors	◯ yes ◯ no	◯ yes ◯ no		

Biosecurity - indicate the presence of:

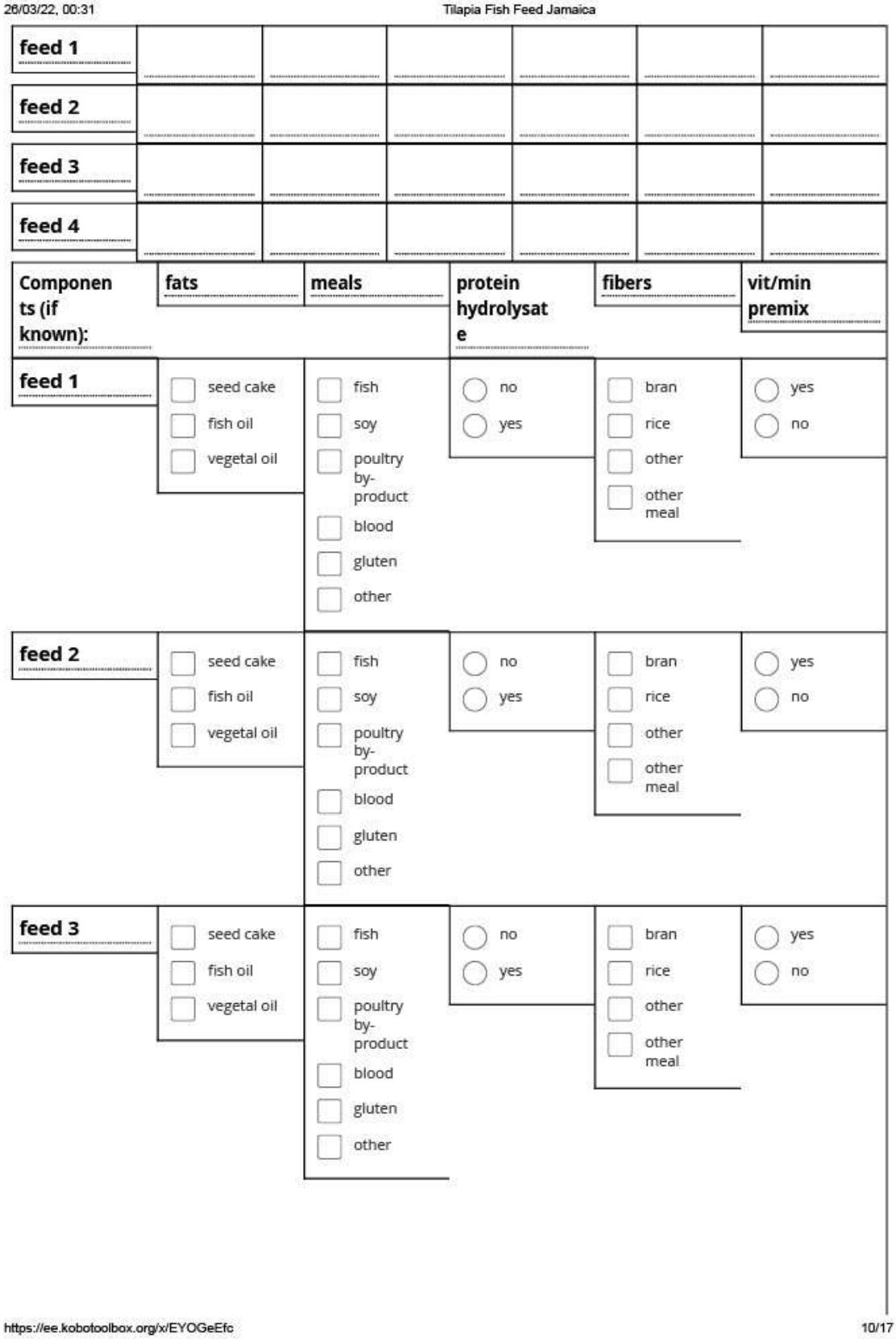
- ☐ fenced area
- ☐ nearby (upstream or around) activities affecting the farm
- ☐ praedial larceny
- ☐ animal predators
- ☐ animal vectors (rodents, dogs, cats, etc.)
- ☐ restricted access to visitors

Remarks:

5. Feed purchased

Feed purchased: type, quantity and price	brand name	origin	type	kg x year	cost (JMD/kg)
feed 1		○ national ○ imported	○ pellet sinking ○ pellet floating ○ pellet extruded ○ powder mix		
feed 2		○ national ○ imported	○ pellet sinking ○ pellet floating ○ pellet extruded ○ powder mix		
feed 3		○ national ○ imported	○ pellet sinking ○ pellet floating ○ pellet extruded ○ powder mix		
feed 4		○ national ○ imported	○ pellet sinking ○ pellet floating ○ pellet extruded ○ powder mix		

Quality (indicate component percentage, if known):	brand name	protein %	fat %	premix vit/min %	fiber %	moisture %



26/03/22, 00:31 Tilapia Fish Feed Jamaica

feed 1						
feed 2						
feed 3						
feed 4						

Components (if known):	fats	meals	protein hydrolysate	fibers	vit/min premix
feed 1	☐ seed cake ☐ fish oil ☐ vegetal oil	☐ fish ☐ soy ☐ poultry by-product ☐ blood ☐ gluten ☐ other	◯ no ◯ yes	☐ bran ☐ rice ☐ other ☐ other meal	◯ yes ◯ no
feed 2	☐ seed cake ☐ fish oil ☐ vegetal oil	☐ fish ☐ soy ☐ poultry by-product ☐ blood ☐ gluten ☐ other	◯ no ◯ yes	☐ bran ☐ rice ☐ other ☐ other meal	◯ yes ◯ no
feed 3	☐ seed cake ☐ fish oil ☐ vegetal oil	☐ fish ☐ soy ☐ poultry by-product ☐ blood ☐ gluten ☐ other	◯ no ◯ yes	☐ bran ☐ rice ☐ other ☐ other meal	◯ yes ◯ no

https://ee.kobotoolbox.org/x/EYOGeEfc 10/17

feed 4	☐ seed cake ☐ fish oil ☐ vegetal oil	☐ fish ☐ soy ☐ poultry by-product ☐ blood ☐ gluten ☐ other	◯ no ◯ yes	☐ bran ☐ rice ☐ other ☐ other meal	◯ yes ◯ no

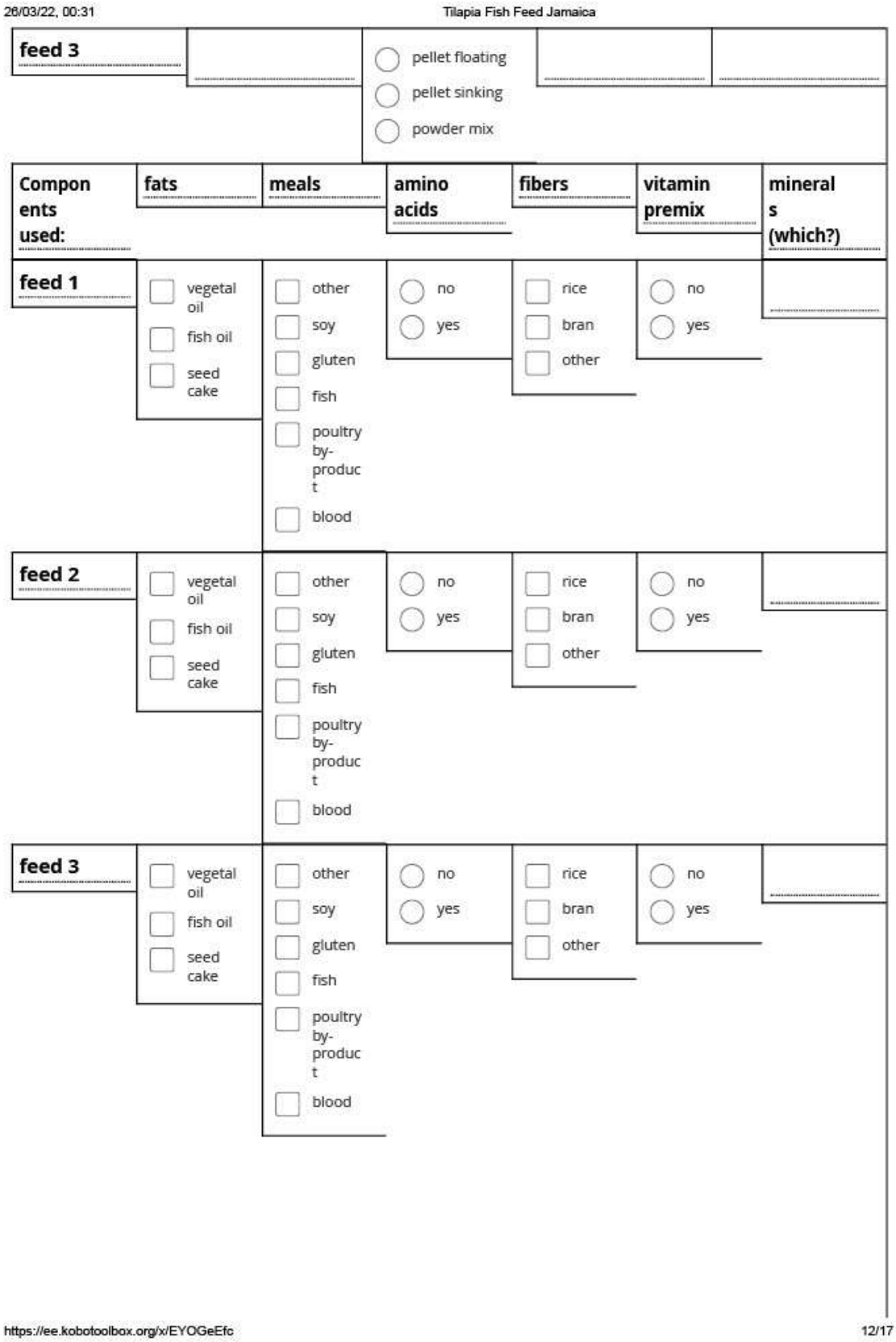
Feed Conversion Factor (if known): fingerling (how many gr of feed to produce 1 fingerling 5 gr)

Feed Conversion Factor (if known): fish (how many kg of feed to produce 1 kg of fish)

Feed problems:
- ☐ low quality
- ☐ limited availability
- ☐ expensive
- ☐ mycotoxin
- ☐ other

6. Feed self-produced (if applicable)

Feed self-produced: type, quantity and cost	size mm	type	kg x year	cost (JMD/kg)
feed 2		◯ pellet floating ◯ pellet sinking ◯ powder mix		
feed 1		◯ pellet floating ◯ pellet sinking ◯ powder mix		
feed 4		◯ pellet floating ◯ pellet sinking ◯ powder mix		


26/03/22, 00:31
Tilapia Fish Feed Jamaica
feed 3
pellet floating
pellet sinking
powder mix
Components used:
fats
meals
amino acids
fibers
vitamin premix
minerals (which?)
feed 1
vegetal oil
fish oil
seed cake
other
soy
gluten
fish
poultry by-product
blood
no
yes
rice
bran
other
no
yes
feed 2
vegetal oil
fish oil
seed cake
other
soy
gluten
fish
poultry by-product
blood
no
yes
rice
bran
other
no
yes
feed 3
vegetal oil
fish oil
seed cake
other
soy
gluten
fish
poultry by-product
blood
no
yes
rice
bran
other
no
yes
https://ee.kobotoolbox.org/x/EYOGeEfc
12/17


26/03/22, 00:31
Tilapia Fish Feed Jamaica
feed 4
vegetal oil
fish oil
seed cake
other
soy
gluten
fish
poultry by-product
blood
no
yes
rice
bran
other
no
yes
Equipment used:
balances
mill
grinding machine
mixer
auto-clave or cooking
pelletizing machine
extruder
other
Green water technology:
used
unused
known
unknown
https://ee.kobotoolbox.org/x/EYOGeEfc
13/17

Potential feed ingredients and by-products available in Jamaica of your knowledge:

- [ ] fish meal
- [ ] soy meal
- [ ] blood meal
- [ ] other meals
- [ ] rice/wheat bran
- [ ] seed cake (from oil industry)
- [ ] brewery industry waste/by-products
- [ ] rum industry waste/by-products
- [ ] sugarcane industry waste/by-products
- [ ] slaughterhouse waste
- [ ] catering industry / restaurant waste
- [ ] food industry waste
- [ ] other

7. Pathologies (if any)

Recurrent pathologies:

.....

Event severity:

- [ ] low
- [ ] mild
- [ ] critical

Means of protection and safeguard (describe):

.....

Medicine / antibiotics used:

.....

8. Farm management cost

Indicate your main management costs (min. 3 - max. 6):

- [ ] equipment/structure/infrastructure maintenance/restoration
- [ ] feed
- [ ] water
- [ ] waste disposal
- [ ] power
- [ ] labour
- [ ] veterinarian services
- [ ] administrative services (accounting, bookkeeping, etc.)
- [ ] marketing services (sale agents, advertising, certification-quality seal, etc.)
- [ ] financial services (bank account, credit, etc.)
- [ ] security services (guarding, porterage, etc.)
- [ ] taxes

9. Services you might be interested in

Outsourcing or pooling (in consortium):

- [ ] fish health care
- [ ] harvesting (fingerling/fish)
- [ ] broodstock selection and genetic
- [ ] processing & packaging
- [ ] filleting & packaging
- [ ] marketing
- [ ] advertising
- [ ] feed production
- [ ] product/production cycle quality control
- [ ] associationism / cooperative

Developing or improving on-farm (also through vocational training):

- [ ] fish health care
- [ ] broodstock selection
- [ ] processing & packaging
- [ ] filleting & packaging
- [ ] marketing
- [ ] advertising
- [ ] feed production

10. Self evaluation of your business (indicate when applicable)

specific courses on your core business attended:

.....

experience (years in business):

.....

best practices applied in your farm:

.....

strong points:

.....

weak points:

.....

risks:

- [ ] strong winds
- [ ] flood
- [ ] drought
- [ ] other

threats:

- [ ] water shortage
- [ ] energy shortage
- [ ] labour shortage
- [ ] technician shortage
- [ ] praedial larceny
- [ ] political and markets instability
- [ ] other

challenges:

.....

opportunities:

.....

remarks:

.....

11. Comments by the interviewer

comments:

12. Relevant photos

Point and shoot! Use the camera to take a photo

Click here to upload file. (< 10MB)

Annex IV - Ornamental Fish Feed Questionnaire form

Ornamental Fish Feed Jamaica

Interview

Enter a date:

yyyy-mm-dd

Interview by:

Farm

Farm name:

Farm address:

Farm address (Parish):

- ◯ St. Catherine
- ◯ Clarendon
- ◯ Manchester
- ◯ St. Elizabeth
- ◯ Westmoreland
- ◯ Hanover
- ◯ St. James
- ◯ Trelawny
- ◯ St. Ann
- ◯ St. Mary
- ◯ Portland
- ◯ St. Thomas
- ◯ Kingston
- ◯ St. Andrew

Farm code (Fishery Division ID Number):

Farm licenses (if the case):

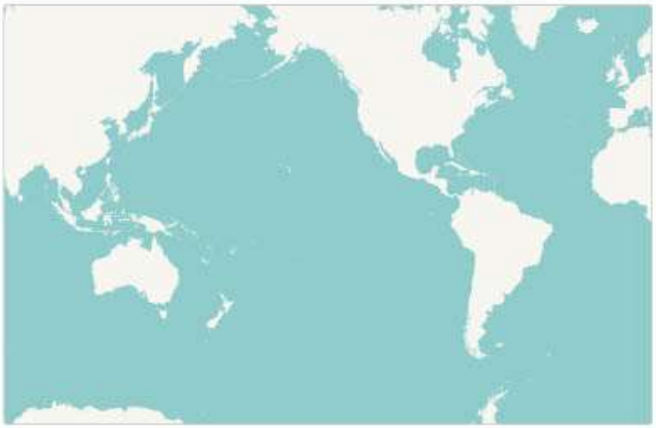
Record your current location (get the GPS position at the farm entrance):

latitude (x.y °)

longitude (x.y °)

altitude (m)

accuracy (m)



1. Briefly describe your farm

Farm size type:

- ◯ urban / peri-urban backyard size farm
- ◯ urban / peri-urban structured medium size farm
- ◯ rural small size farm
- ◯ rural medium/large size farm

Farm business type:

- ◯ part-time
- ◯ full-time

Production cycle:

- ◯ only breeding (larvae and juveniles)
- ◯ only grow-out
- ◯ complete cycle, from breeding to grow-out

2. In case your farm includes breeding

What's the goal?

- ◯ only for internal use
- ◯ only for larvae/juveniles sale
- ◯ both, for internal use and larvae/juveniles sale

Juveniles produced per year:	No.	if sold, at what unit price (JMD)?
cool water Cyprinids (koi, carps, goldfish)		
Poecillids (guppies, mollies, swordtails, platies)		
tropical Cyprinids (barbs, danio)		
Catfish (corydoras, pleco)		
Characins (tetras)		
Cichlids (angel, discus, oscar)		
Sharks (red tail, rainbow, iridescent)		
Anabantids (fighters, gourami, paradise)		
Cyprinodonts (killifishes)		

Production time (average number of days from spawning to juveniles):

Percentage of larvae going to juveniles (mortality):

3. In case your farm includes grow-out

What is the juveniles origin?	quantity %
internal production	
purchased from external source	

In case of purchased juveniles, indicate for each strain:	main species	source	supplier name	No.	approx. unit cost (JMD)
cool water Cyprinids		◯ foreign ◯ domestic			
tropical Cyprinids		◯ foreign ◯ domestic			
Sharks		◯ foreign ◯ domestic			
Catfish		◯ foreign ◯ domestic			
Cyprinodonts		◯ foreign ◯ domestic			
Anabantids		◯ foreign ◯ domestic			
Cichlids		◯ foreign ◯ domestic			
Poecillids		◯ foreign ◯ domestic			
Characins		◯ foreign ◯ domestic			

Adult fish sale:	No.	unit sale price (JMD)
Anabantids		
tropical Cyprinids		

Poecillids		
Catfish		
Cyprinodonts		
Cichlids		
Characins		
cool water Cyprinids		
Sharks		

Type of sale:	**quantity %**
directly to aquarium owners (private, hotels, etc.)	
to retailers (pet shop, show, supermarket, other)	
to national wholesalers	
to export wholesalers	
directly to foreign clients	

In case of sale directly to foreign clients, indicate the main client countries:
Production time (average number of days from juveniles stage to adult sale):
Percentage of juveniles going to adult sale (mortality):

4. Site description

Buildings:	**No.**	**total square meters**
for administrative use		
for production use		

for laboratory use		
for storage use		
for other use		

Power supply:
- ◯ public grid
- ◯ generator
- ◯ both

Accessibility:
- ◯ no road
- ◯ dirt road
- ◯ paved road

Breeding system (if present):	**type**	**No.**	**container average dimensions H-W-L (cm)**	**No. of species raised per container**
aquaria	☐ glass ☐ plastic ☐ cement ☐ autoconstructed			
tanks	☐ glass ☐ plastic ☐ cement ☐ autoconstructed			
recycled containers	☐ glass ☐ plastic ☐ cement ☐ autoconstructed			

other	☐ glass ☐ plastic ☐ cement ☐ autoconstructed				

Grow-out system (if present):	**type**	**No.**	**tank overall volume / pond overall surface**	**stocking density (No. x m2)**	**No. of species raised per container**
tanks	☐ plastic ☐ cement ☐ earthen ☐ autoconstructed				
ponds	☐ plastic ☐ cement ☐ earthen ☐ autoconstructed				

Indicate retrofit, if any:

- ☐ water recirculation systems
- ☐ water filtration systems
- ☐ water quality test kits
- ☐ air pumps
- ☐ separate tanks/containers for breeders, juveniles, larvae, grow-out
- ☐ tanks in roofed areas
- ☐ tanks with light covering (to prevent debris and insect entry)
- ☐ tanks raised off the ground
- ☐ paved and washable floors
- ☐ areas with good drainage systems

Water source:	**availability**	**mc x hour**	**mc used x week**
tap water	○ year-round ○ seasonally		

borehole	○ year-round ○ seasonally		
river / stream	○ year-round ○ seasonally		
other	○ year-round ○ seasonally		

Water quality:	temp. min. (°C)	temp. max. (°C)	pH	salinity (gr/kg)	hardness (°F)	oxygen (mg/L)	coliforms
parameters							○ yes ○ no

Water effluent treatment / depuration:

○ present
○ not present

Hygiene:	washing	disinfection	chemical / detergent used	frequency
equipment	○ yes ○ no	○ yes ○ no		
tanks / containers	○ yes ○ no	○ yes ○ no		
areas / floors	○ yes ○ no	○ yes ○ no		

Biosecurity - indicate the presence of:

- [ ] fenced or closed area
- [ ] nearby activities affecting the farm
- [ ] praedial larceny
- [ ] animal predators
- [ ] animal vectors (rodents, dogs, cats, etc.)
- [ ] restricted access to visitors

Remarks:

5. Feed

Total amount of feed used per year:	kg x year	% purchased	% supplemental homemade
total feed used			

Purchased feed: type, quantity and cost	brand name	origin	type	kg x year	cost (JMD/kg)
feed 1		○ national ○ imported	○ other ○ unknown ○ tilapia ration ○ koi stick ○ aquarium feed ○ salmon starter		
feed 2		○ national ○ imported	○ other ○ unknown ○ tilapia ration ○ koi stick ○ aquarium feed ○ salmon starter		

feed 3		○ national ○ imported	○ other ○ unknown ○ tilapia ration ○ koi stick ○ aquarium feed ○ salmon starter		
feed 4		○ national ○ imported	○ other ○ unknown ○ tilapia ration ○ koi stick ○ aquarium feed ○ salmon starter		
Purchased feed: main components (if known)	**c1**	**c2**	**c3**	**c4**	**c5**
feed 1	☐ brine shrimps ☐ water fleas ☐ krill	☐ worms - larvae ☐ beef heart	☐ beta carotene ☐ spirulina	☐ fish/squid meal ☐ whole wheat ☐ soybean meal ☐ other meal	☐ vitamins ☐ hormones ☐ fats
feed 2	☐ brine shrimps ☐ water fleas ☐ krill	☐ worms - larvae ☐ beef heart	☐ beta carotene ☐ spirulina	☐ fish/squid meal ☐ whole wheat ☐ soybean meal ☐ other meal	☐ vitamins ☐ hormones ☐ fats

feed 3	☐ brine shrimps ☐ water fleas ☐ krill	☐ worms - larvae ☐ beef heart	☐ beta carotene ☐ spirulina	☐ fish/squid meal ☐ whole wheat ☐ soybean meal ☐ other meal	☐ vitamins ☐ hormones ☐ fats
feed 4	☐ brine shrimps ☐ water fleas ☐ krill	☐ worms - larvae ☐ beef heart	☐ beta carotene ☐ spirulina	☐ fish/squid meal ☐ whole wheat ☐ soybean meal ☐ other meal	☐ vitamins ☐ hormones ☐ fats

Purchased feed: main problems

- ☐ low quality
- ☐ limited functionality
- ☐ limited availability
- ☐ expensive
- ☐ other

Supplemental homemade feed: type, quantity and cost	**type**	**kg x year**	**cost (JMD/kg)**
homemade 1	◯ powder ◯ pellet ◯ other		
homemade 2	◯ powder ◯ pellet ◯ other		
homemade 3	◯ powder ◯ pellet ◯ other		

Supplemental homemade feed: main components used

- [ ] artemia
- [ ] daphnia
- [ ] mosquito larvae
- [ ] egg yolk
- [ ] oat
- [ ] canned sardines
- [ ] raw or boiled egg
- [ ] earthworm
- [ ] beef heart
- [ ] fish meal
- [ ] soybean meal
- [ ] whole wheat
- [ ] other meal

Supplemental homemade feed: indicate homemade components, if any

- [ ] artemia
- [ ] daphnia
- [ ] mosquito larvae
- [ ] egg
- [ ] earthworm

Supplemental homemade feed: main problems/challenges

- [ ] improving artemia culture
- [ ] improving daphnia culture
- [ ] improving earthworm culture
- [ ] component availability
- [ ] component costs
- [ ] better or adequate equipment

Green water technology:

- [ ] used
- [ ] unused
- [ ] known
- [ ] unknown

6. Pathologies

Recurrent pathologies, if any:

.....

Event severity:

- [ ] low
- [ ] mild
- [ ] critical

Means of protection and safeguard:

- [ ] none
- [ ] regular equipment cleaning/disinfection
- [ ] regular water quality control
- [ ] visual disease control by the owner
- [ ] specialist desease control by veterinarian
- [ ] low stock density
- [ ] other sanitary procedures

Medicine / antibiotics used:

.....

7. Farm management cost

Indicate your main management costs (min. 3 - max. 6):

- [ ] equipment (filters, air-pumps, piping, faucets, valves, etc.), maintenance/restoration
- [ ] aquaria, tanks, ponds, structures (roofing, building, etc.), maintenance/restoration
- [ ] lab maintenance
- [ ] feed
- [ ] water consumpion
- [ ] water quality control
- [ ] power
- [ ] labour
- [ ] veterinarian services
- [ ] administrative services (accounting, bookkeeping, etc.)
- [ ] marketing services (sale agents, advertising, certification-quality seal, etc.)
- [ ] financial services (bank account, credit, etc.)
- [ ] exporting services (veterinary controls, custom controls, custom charges, etc.)
- [ ] taxes

8. Services you might be interested in

Outsourcing or pooling (in consortium):

- [ ] fish health care and disease control
- [ ] breeding (larvae/juveniles)
- [ ] broodstock selection and genetic
- [ ] packaging
- [ ] marketing
- [ ] advertising
- [ ] exporting
- [ ] feed production
- [ ] product/production cycle quality control
- [ ] associationism / cooperative

Developing or improving on-farm (also through vocational training):

- [ ] fish health care and disease control
- [ ] broodstock selection
- [ ] packaging
- [ ] marketing
- [ ] advertising
- [ ] exporting
- [ ] feed production

9. Self evaluation of your business (indicate when applicable)

specific courses on your core business attended:

.....

experience (years in business):

.....

best practices applied in your farm:

.....

strong points:

.....

weak points:

.....

threats:

- [ ] water shortage
- [ ] water quality
- [ ] water increasing cost
- [ ] energy shortage
- [ ] energy increasing cost
- [ ] domestic market instability
- [ ] foreign market instability

challenges:

opportunities:

remarks:

10. Comments by the interviewer

comments:

11. Relevant photos

Point and shoot! Use the camera to take arelevant/significant photo

Click here to upload file. (< 10MB)

Annex V - Photos






FARMERS MARKET
FRESH WATER FISH
FOR SALE