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PROFITABILITY ASSESSMENT: A CASE STUDY OF A MARINE RECIRCULATING AQUACULTURE SYSTEM (MRAS) IN TRINIDAD

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ABSTRACT

The research paper presents a profitability assessment model developed to evaluate the feasibility of shrimp farming using a marine recirculating aquaculture system (MRAS). A case in Trinidad is used for the evaluation in the production of the Pacific White shrimp (*Litopenaeus vannamei)*. The main assumptions for the evaluation were derived from a marketing survey, primary data from production and personal experience. The data collected was inputted into a production model with a production capacity of 3 tonnes. To evaluate the profitability of the model, indicators of investment returns were computed such as net present value (NPV), internal rate of return (IRR), payback period, and debt service coverage ratio. A sensitivity analysis on sales price, yield, cost of equipment, variable and fixed costs were conducted. The results of the analysis indicate that shrimp farming is financially feasible based on a sales price of TTD $77/kg and a yield of three tonnes/year. The results obtained indicate a positive NPV, an acceptable IRR and a payback period of six years. A debt service coverage ratio of more than 1.5 was obtained thus indicating that the cash flow is adequate. Sensitivity analysis on sales price, yield and costs indicate that the model is highly sensitive to yield and sales price but less sensitive to fixed and variable costs.

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1 INTRODUCTION

1.1 Background

Approximately 20% of the world's population derives at least one-fifth of its animal protein intake from fish, whereas small island states depend almost exclusively on fish (WHO). As a result, the importance of fish and fishery product as an element of human food supply and the overall fishing sector cannot be understated in lieu of a growing population. Current harvest trends and fishery conditions put both of these fundamental dynamics at risk as a declining fish stock and increasing consumption creates a platter for food insecurity. Within both the developed and developing world, there have been increases in fish demand at more than 2.5 percent per year (Peterson and Fronc, 2007). (Garcia and Rosenberg 2010) further highlight that as nations become more concerned with their health, and their food security coupled with rising wealth there is a shift in demand levels for fishery product and overall demand levels are likely to rise more strongly.

Bearing this in mind together with projections which suggest that the contribution of fish to the global food supply is likely to decrease as wild stocks are declining and the main sources of fish and other aquatic life are struggling to keep pace with demand, it has become increasingly important for counteractive measures in dealing with this phenomenon (FAO 2014).

Aquaculture has been pinpointed as one avenue of remedy for treating with food security and aiding in the supply of world fish supply. Aquaculture plays a crucial role for food security as a purveyor of food availability, livelihoods and income, particularly for vulnerable and marginalized populations (HLPE 2014). Aquaculture has expanded very rapidly and is now the fastest growing food-producing industry in the world (Tidwell and Allan 2001). Capture fisheries production is anticipated to be stable at 2010 levels and aquaculture production is expected to exceed that of capture fisheries in 2015 and to reach 53 percent of total human consumption by 2022 and 62 percent by 2030 (World Bank, 2013). Bearing this in mind, it would be slipshod of developing nations to not take note of this worldwide development as an example in treating with their food security.

Developing nations have been experiencing the effects of international scarcity as many of them depend on food imports from developed countries. However, except for Jamaica in the Caribbean region and Belize in Central America, few island states have capitalized on the aquaculture opportunity.

1.2 Economic overview of Trinidad and Tobago

The twin island state of Trinidad and Tobago is located on the edge of the continental shelf of North East South America and is the southernmost island of the Lesser Antilles chain. With a population of 1.3 million people and a Gross Domestic Product (GDP) of US $23.559 billion it is said to be one of the richest countries in the Caribbean. Consisting of an area of 5,128 km² it is a small but a very affluent country characterized by rich natural resources and one of the highest Gross National Incomes (GNI) in the Latin America and the Caribbean US$18,600 in 2015, Atlas method (World Bank 2016).

The economy is based on oil and natural gas production, as well as ammonia, fertilizer, steel/iron, ethanol, construction, mining, quarrying and financial services (Worl Bank, 2016). The energy sector accounts for approximately 40% of GDP and accounts for over 80% of the country's exports and approximately 50% of the government revenues (Carib-Export, 2007).
During the period 2011 to 2014 the direct foreign investment and local private sector investment within the economy, simultaneous with reduced natural gas prices and falling Liquefied Natural Gas (LNG), oil, fertilizer and methanol output all combined to significantly lower the government revenues.

As reported on 4th December 2015, the Central Bank of Trinidad and Tobago (CBTT) indicated the country was officially in a recession after experiencing four consecutive quarters of declining GDP. It is estimated that in 2015 the economy declined by 1.5%. By the year end 2015, there were decreases in natural gas production (7%), crude oil production (14%), new car sales (22%) and cement sales (14%). To mitigate against the decline in the economy, the government implemented measures to improve its revenue by the removal of subsidies, indirect taxes, restricting of education and employment programmes and increasing the debt ceiling of the country.

In a summary of the Central Band of Trinidad and Tobago 2016 Bulletin dated April 8th, 2016 the national economy will contract 2.3%, foreign exchange reserves of US $8,524.9 million will decrease, unemployment and inflation will increase, public sector debt will rise and the current deficit will deepen. These changes have been experienced by the population in ways such as decreased economic activity or sales particularly in the manufacturing sector and new cars, increased fuel prices due to the removal of subsidies, increased taxes on imported goods, decrease in education grants and unemployment relief programmes, increase in unemployment and decreased availability of foreign exchange for business transactions.

1.3 Bridging the gap

Presently as the economy is suffering a recession there is an opportunity to explore the full potential and benefits of aquaculture as a food security issue and as a contribution to the country's economy. As part of its mandate the Aquaculture Department (AD) of the Seafood industry development Company Limited (SIDC) embarked on a pilot project to determine the technical feasibility of cultivating Pacific white shrimp, *Litopenaus vannamei*.

The objective of this study is to develop an aquaculture business model for profitability analysis of aquaculture farming. The Marine Recirculating Aquaculture System (MRAS) at the SIDC located at #6 Bejucal Extension, Uriah Butler Highway, Charlieville, Trinidad will be the case study. This model will be used to assess the financial viability and sustainability of the marine aquaculture system as well as other aquaculture systems in the country.

Trinidad and Tobago have practiced aquaculture since the 1990s but to date the industry has not been able to develop to a competitive level to contribute to the agriculture sector. One strategy is to assess the feasibility of existing aquaculture systems to ensure farmers, fishermen, private investors and Small and Medium Enterprises (SMEs) are receiving interest on their investments to reinvest and grow. Other strategies that can follow are the selection of the most feasible farms to increase production in the near future, increased training and extension services for potential farms in the form of applied research to facilitate technology transfer and information.

1.4 Main tasks

The main objectives of the study were as follows:

1. To evaluate the profitability of a marine recirculating aquaculture system (MRAS) producing the *L. vannamei* species of shrimp.
2. To develop an aquaculture business model to evaluate the profitability of operating an aquaculture system.
    - Potential target groups; fishermen, farmers, private investors and small and medium enterprises (SME's) and the Government
3. Examine all the investment and operating costs required to setup an aquaculture business to inform stakeholders and make recommendations that would facilitate the development of the sector.
4. Identify economic potential and constraints regarding aquaculture in Trinidad and Tobago.
5. Conduct marketing research for farmed shrimp to determine the size and market form required by the various market segments, a suitable price for the product and the acceptability of the product as well as to ascertain the quantity and frequency of shrimp required by the restaurants to assist in production planning.

2 PROJECT RATIONALE

In Trinidad, feasibility of the aquaculture industry has not been fully examined in terms of its economic viability and realization of good profit margins (Jobity, 2012). This has partly hindered the development of aquaculture in Trinidad as farmers or potential investors are not aware of the profitability. This has led to improper planning and design of systems and some systems going dormant. There is also the lack of financing options available as financial institutions are unaware of the feasibility of the operation.

As a result, the Seafood Industry Development Company Limited (SIDC) pioneered research into mariculture, with several species and production systems identified for exploration. In 2015, the SIDC embarked upon research on the culture of the Pacific white shrimp (*Litopenaeus vannamei*) in tanks, using a culture system referred to as a marine recirculating aquaculture system (MRAS). This system recirculates, reconditions and reuses water to culture aquatic animals.

The primary aim of the SIDC's MRAS is to conduct research on the biological, ecological and economic benefits of marine shrimp farming in this type of production system. This research will then be presented to local aquaculture farmers, shrimp fishermen, potential investors and other stakeholders. The stakeholders in the industry are Ministry of Agriculture, Land and Fisheries (MALF), Institute of Marine Affairs (IMA), Sugarcane Feeds Centre (SFC), Caribbean Fisheries Training and Development Institute (CFTDI), Agriculture Development Bank (ADB) and Environmental Management Authority (EMA).

Similar research has also been conducted by the IMA using the same species but to date there is no economic analysis presented to conclude the viability of the system.
A marketing analysis will be conducted which will be inputted in the production planning model and a profitability model will be developed. The products of the study will be used as guides for

prospective and existing fish farmers in Trinidad and Tobago. The information generated will provide all stakeholders with the knowledge to determine profitability of their farms and also, assist lending institutions to better assess the viability of aquaculture projects and reduce the rate of failure in loan repayment.

It is expected that the existing marine recirculating system will be able to provide the local market with high quality shrimp, also profitable small-scale fish farms will, in the future, supply the local market with fish. Furthermore, it is anticipated that local per capita fish consumption would increase. Per capita fish consumption stood at 14 kg per person (JIICA 2003) which is below the world average per capita consumption of 16kg per person.

The productions from aquaculture will also supplement catches from marine fisheries. Further, it is expected that a successful and well developed small scale aquaculture industry could trigger a commercial aquaculture industry in the country. In addition, the subsistence farmers might grow in capital and knowledge and transform themselves into small and medium and eventually large-scale farmers.

The methodology developed can easily be adapted to evaluate any type of investment, for instance fish farming enterprises of other species or fishery operations.

3 LTERATURE REVIEW

3.1 Aquaculture in Trinidad

The term aquaculture is not new to Trinidad and Tobago, as this method of producing aquatic species namely tilapia has existed from 1990s under the state-owned Caroni (1975) Limited. This production took place in earthen ponds producing the red tilapia strains and were introduced in 1983 and production increased significantly from 1994 to 1998, reaching a maximum of 26 tonnes (Ramnarine 2000). This production consisted of a hatchery, concrete tanks and earthen ponds ranging in sizes of 0.5 to 1 hectare.

Another state-owned agency called the Bamboo Grove Settlement Farm was also involved in tilapia production in earthen ponds. Recently, it has been allocated to serve as the office for the MALF's Aquaculture Unit demonstration farm. It consists of meeting rooms for lectures, earthen ponds and concrete tanks with live tilapia as well as a hatchery with tilapia fingerlings and ornamental fish.

The SFC, a state-owned institution responsible for research, demonstration and training in the agriculture sector including aquaculture is also involved in aquaculture. Located on sixty (60) hectares of land, approximately one hectare is allocated for the earthen ponds for tilapia production and a hatchery. In addition, there is a small wet processing facility which operates at scheduled times for the processing of tilapia into a whole, scaled and gutted product and fillets (skin-on).
The IMA located on the western peninsular of the island has also contributed to the research and production of tilapia fingerlings and tilapia utilizing different types of cultures. This agency consists of a hatchery and a few small earthen ponds. They were also responsible for the research

of a Clear Water Recirculating System utilizing large fiberglass tanks 20/ft. in diameter and mechanical and biological filtration equipment to produce tilapia.

To date, there are approximately one hundred persons practicing aquaculture ranging from hatcheries to grow out systems and aquaponics. These farmers are considered small farmers with few producing large quantities to supply the market. However, there has been no sustainable growth in the sector with respect to production or policy to demonstrate any degree of development.

In 2013, the SIDC established an Indoor Marine Facility using a recirculating aquaculture system at its headquarters in Charlieville, Chaguanas, in order to produce high priced, high value marine fish for local and export markets.

The vision for the SIDC's Marine Aquaculture Facility is to:

- become an exemplar for marine production systems in a land-based, highly controlled, Recirculating Aquaculture System (RAS) to produce high quality fish that is sustainably produced in an environmentally friendly, disease controlled contaminant-free and bio-secure operation;
- process into value- added products that will achieve broad market acceptance and effective demand in local and export markets, delivered regularly, year-round at competitive prices,
- be used as a model farm for sustainable marine food production, provide technical knowledge to stakeholders and offer training seminars and workshop on sustainable marine production systems.

Initiated as a pilot inland marine shrimp project, the SIDC shall determine the technical and commercial feasibility of intensively culturing the Pacific white shrimp (*L. vannamei*) in a tank-based production system.

This project proposes the production of marine shrimp in a sustainable way utilizing recirculating aquaculture systems in a Pilot Marine Shrimp Farm. This will provide an alternative income for displaced shrimp fishers, shrimp vendors, and other interested communities to provide a sustainable shrimp production to the nation and for export.

It will also serve as a training centre for collaborative stakeholders as well as a catalyst to modernize the fish and fish processing sector of Trinidad and Tobago by partnering with stakeholders and providing them with project management, research, publishing, training and mentoring development. This will be possible with the support and joint efforts of the supporting agencies and stakeholders.

3.2 Overview of the shrimp industry in Trinidad and Tobago

Shrimp fishing mainly occurs off the West coast of Trinidad, in the Gulf of Paria, by artisanal and semi-industrial fleets, there is also some fishing which takes place off the northwest coast off the south coast, by mainly semi-industrial and industrial trawlers (Hutchinson *et al*., 2007). At present, 96 percent of exports go to the Caribbean Community (CARICOM). There is also a high incidental fish catch associated with shrimp trawling in Trinidad. This causes considerable

conflict between the trawl fishery and capture fisheries in the country. Other issues such as the fully, exploited or overexploited condition of shrimp stocks species as well as that of high levels of bycatch and the degree of overcapitalization in the trawl fishery.

It is estimated that the contribution to GDP for Trinidad and Tobago is approximately 0.2%. Also, it is estimated that trawl fisheries are responsible for 20% of all fishery landings in Trinidad and Tobago. The general perception is that the shrimp fishing GDP contribution is small and results in the view that shrimp fisheries do not have a great importance in the overall economy. Additionally, in the case of Trinidad and Tobago having a large petroleum industry tends to overpower the economic importance of shrimp fishing.

In 1999 to 2004, annual shrimp catches averaged about 825 tonnes. In 2004, there was an estimated 785 tonnes of shrimp landed, valued at US$2.72 million, and 703 tonnes of ground fish bycatch valued at US$0.65 million (FAO 2008). However local fisheries indicate that shrimp landings have increased by approximately 20% since 2004 where for the period 2011 and 2012 shrimp landings stood at 17,000 tonnes and 16,000 tonnes respectively. The shrimp was valued at over TT$32 million or US$5 million (Fisheries Division, 2012). There has also been a decline in the volume and value of frozen shrimp exported from Trinidad and Tobago from 2003 to 2009 with a corresponding increase in imported frozen shrimp.

Shrimp is landed by all classes of trawlers and is handled and processed by privately owned companies. There are approximately 10 large processors that operate on a full-time basis and process shrimp and finfish. Shrimp is also landed in an ad hoc manner and graded manually according to size and sold at retail markets. Catches destined for the domestic market are landed and sold fresh chilled. The shrimp destined for the domestic market is sold to wholesale markets, itinerant vendors (van sales), restaurants, supermarkets and privately (Figure 1).

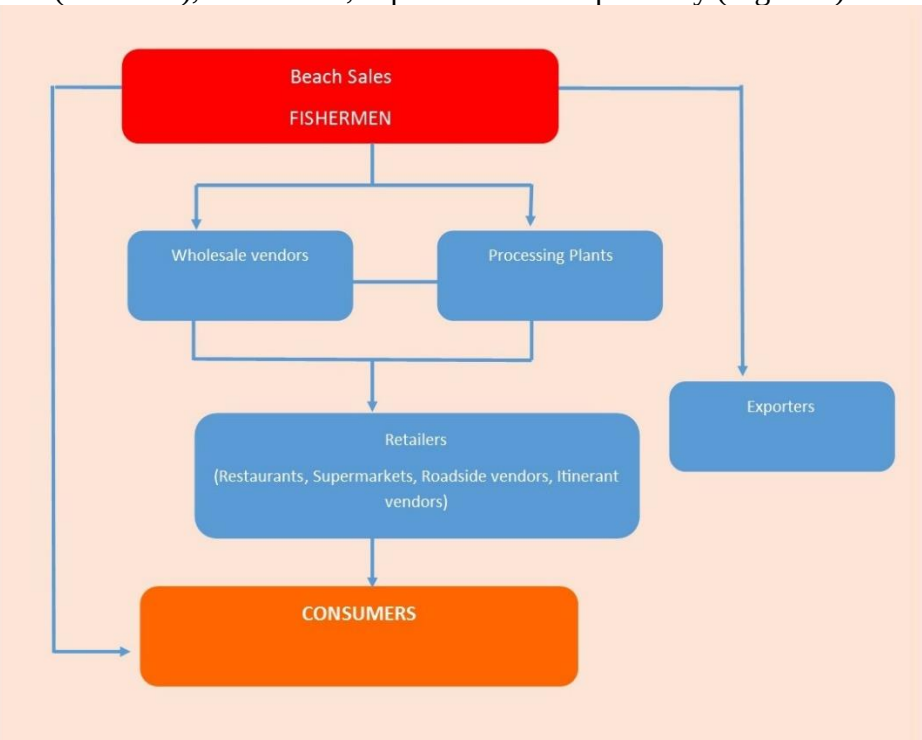

Figure 1: Seafood Distribution Channel in Trinidad and Tobago

4 METHODOLOGY

4.1 Market analysis

4.1.1 Primary data

Primary data was collected via questionnaires that were delivered utilizing various distribution channels such as Survey Monkey, email, interview and telephone. This quantitative method was selected as it allowed for important data to be extracted from the target market. The questionnaire was developed to collect information such as price, demand, size preferences, type of product and market form and competition. Data was collected over a three-week period, from 6th January to 20th January 2017 (see Appendix I).

4.1.2 Market selection

The target market are restaurants and the group of restaurants were compiled using the internet and local and international food and travel guide related websites. These websites offer up-to-date reviews and comments and promotes new restaurants or culinary events.

For the purpose of this research, restaurants were grouped into four categories (segments); Sushi, Fine Dining, Chinese and Casual Dining /Sports Bar. Ten (10) restaurants were randomly selected for the categories Fine Dining, Chinese and Casual/Sports Bar and nine restaurants were randomly selected for the Sushi category. Thirty-nine (39) samples were delivered to the various restaurants on 6th January, 2017.

4.1.3 Distribution of samples

The farm-raised *L. Vannamei* was obtained from the Indoor Marine Recirculating Aquaculture System (MRAS). The shrimp was harvested approximately three hours before the departure for delivery. A weight of 37.15 kg of shrimp was harvested at an average body weight (ABW) of 30.83 grams per shrimp or 10/15 count.

Thirty-nine, two-pound (2 lb.) samples were prepared for distribution using clear polythene zip bags for packaging which were then packed and stored in insulated fish boxes with ice. Samples were then delivered to 39 restaurants as a chilled, shell-on head-on along with an introductory letter of the organization, a product fact sheet and a questionnaire.

4.1.4 Analysis of results

Responses from the returned questionnaires was collated and analysed using Microsoft Excel.

4.2 Production model

4.2.1 Data collection and main assumptions

The study involved the collection of primary data on shrimp farming using a marine recirculating aquaculture system located in Trinidad. The information was collected on a daily and weekly basis using best practice record keeping standards by the technical staff during the production cycle.

Other information was obtained from personal experience gained from shrimp farming research. Many assumptions were made about shrimp production characteristics during any given cycle (Table 1).

4.2.2 Production planning model

Based on the assumptions in the table, a production model was developed. The model comprised of two marine recirculating aquaculture systems (MRAS) named MRAS 1 and MRAS 2 with a total of 148/m³. Upon receiving of the post larvae, MRAS 1 will be used as quarantine for a period of 20 days or when the post larvae are 30 days. During this period the post larvae was fed a ration of live food such as brine shrimp (*Artemis sp.)*, micro algae (*Isochrysis galbana*, *Nannochloropsis occulata*, *Tetraselmis sp.*), rotifers (*Brachionus plicatilis*) and extruded pelleted marine shrimp feed (Gisis/Guabi). Live feed was used as it is cost effective, nutritious and versatile.

After the quarantine period, the post larvae were transferred to MRAS 2 for stocking. The stocking density used is 450 shrimps per m³. The production tanks were stocked with approximately 3,500 and 14,000 post larvae in 10 ft. in diameter polyethylene tanks and 20 ft. in diameter fiberglass tanks for grow out. During the grow-out period the production tanks were sampled to determine growth rates (cm), mean body weight (g) and survivability (%). This information was used to determine biomass during the production cycle and to calculate feeding requirements during the period (Table 2 & 3).

Table 1:The main assumptions used in the production of shrimp using the marine recirculating system in Trinidad (it is assumed that the two systems MRAS1 & MRAS2 are stocked at the same time). The assumed values are based on references discussed in the text

Characteristic	Assumptions	Source
Stocking density	450 shrimp/m³	SIDC
Initial weight of post larvae	4 g	
Cost of post larvae	$0.15 TT/animal	SIDC
Survivability	70%	
Cycle length	16 weeks	SIDC
Harvest weight	20 g	
Shrimp price	$77 /kg	SIDC
Yield live shrimp	3 tons	
FCR	1.85	SIDC
Cost of feed	$30 /kg	SIDC
Interest on loan	5%	ADB
Discounting rate	10%	
Depreciation equipment	10 years	
Financing	828,090.00	
Loan	70%	
Equity	30%	
Working capital	TTD$100,000	
Other assumptions:		
Area	10,000 sq. ft.	
Rental costs	TTD$27000	
Number of tanks in farm	10	
Month days	30	
Batch cycle length	16 weeks	
Buildings	TTD$250,000.00	Fixed costs
Equipment	TTD$361.935.00	
The operation is super-intensive		

The water quality was closely managed daily by testing and recording of both physical and chemical parameters. The physical parameters were temperature, dissolved oxygen, salinity, turbidity, conductivity and total dissolved solids whilst the chemical parameters tested were total ammonia, nitrite and nitrates. The physical parameters were tested and recorded daily and the chemical tests were performed once weekly or when required.

At the end of 16 weeks the shrimp was harvested from the systems and sold at TTD $77.00 /kg. The costs incurred during the production period were determined and subtracted from the sales at the end of the production cycle.

After harvesting, each system was repaired, cleaned, sanitized and the marine water treated. These activities took one week. Based on the assumptions in Table 2, production is projected over a period of ten years. The purpose of this time period was to have continuous production utilizing both systems and to generate economic returns over the period.

Table 2: Production planning model for Pacific white shrimp showing number of shrimp, growth rate, biomass, feeding rate and cost of feed

Week	Number of shrimp	Mean body weight (g)	Biomass (kg)	Feeding rate (%/biomass/kg)	Feeding (kg/148 m^3/day)	Cost of feed (TT)
0	66,578	0	0	0		0
1	65,330	0.2	13	Live food	24	720
2	64,105	0.9	58	Live food	83	2,490
3	62,903	1.5	94	Live food	68	2,040
4	61,723	2.2	136	Live food	77	2,310
5	60,566	4.1	248	25	208	6,240
6	59,430	5.5	327	15	145	4,350
7	58,316	7.9	461	10	248	7,440
8	57,223	11.4	652	10	355	10,650
9	56,150	13.3	747	7	175	5,250
10	55,097	16.1	887	7	259	7,770
11	54,064	20.7	1119	5	179	5,370
12	53,050	19.3	1024	5	74	2,220
13	52,055	20.7	1078	3	99	2,970
14	51,079	21.9	1119	3	76	2,280
15	50,122	22.5	1128	3	17	510
16	49,182	24.4	1200	3	134	4,020
					2,221	$ 66,630.00

Table 3:Stocking density for *Litopenaeus vannamei* (SIDC) for MRAS1 & MRAS2

Tank (MRAS 1)	1	2	3	4	5	**Total**
Estimated Average body weight (ABW)	0.20	0.20	0.20	0.20	0.20	**0.20**
Estimated Pop. (number of shrimp)	3506	3506	14013	3506	3506	**28,035**
Vol of water/tank m^3	7.79	7.79	31.14	7.79	7.79	**62.30**
Stocking density m^3	450	450	450	450	450	**2,250**

Tank (MRAS 2)	1	2	3	4	5	**Total**
Estimated Average body weight (ABW)	0.20	0.20	0.20	0.20	0.20	**0.20**
Estimated Pop. (number of shrimp)	3506	3506	3506	14013	14013	**38,543**
Vol of water/tank m^3	7.79	7.79	7.79	31.14	31.14	**85.65**
Stocking density m^3	450	450	450	450	450	**2,250**

4.2.3 Profitability model

A profitability model was developed based on the results of the production model. In determining the costs, the marine aquaculture facility was considered as a production unit for a period of one year. The profitability model had the following main components: summary assumptions and results, investment and finance, operations statement, cash flow, balance sheet, profitability measurements and sensitivity analysis (Appendix).

By entering the assumptions, the model generated the cash flow over the planning period. The model was also used to calculate the indicators of investment returns such as net present value (NPV), and internal rate of return (IRR), payback period and debt service coverage ratio. Such indicators are important in evaluating the profitability of the venture.

Factors such as yield, prices, and interest rates vary over time and subject farmers or investors to risk. Profit estimates that take risk into account are more realistic. In the production cycle certain prices, quantities and costs may be highly variable resulting in a large effect on net returns. Sensitivity analyses were done by varying the production costs as this consisted of variables. In a sensitivity analysis, a range of possible values for the particular price or quantity in question were substituted for the mean value and a table developed (or charts generated). By doing this, it was possible to study the impact of changing one parameter at the time.

4.2.4 Planning farm operations

The profitably model was used to plan the cash flows over the 10-year planning period. The investment and finance schedule indicated how much finance the farmer needed (equity plus loan), interests, repayment and depreciation (depreciation needed for tax calculation). The operations statement showed the net profits after subtracting the costs from the revenue. The cash flow statement indicated the surplus (losses and /or gains) over the 10-year period. Also, the cash flow indicates how much of the loan can be repaid and during what period in the years of production. The balance sheet was used to keep track of the accounting of the farm.

The profitability measurements showed how the cash flows could be used in the calculations of NPV and the IRR. It should be noted that besides serving as a decision support tool for investment analysis, the profitability model can be used during operations as a planning tool year by year. The balance sheet reflected the assets and liabilities during the operations. Profitability measurements NPV, IRR and financial ratios indicated the feasibility of the venture over the years (Appendix).

4.3 Profitability analysis

The methodology for this research was quantitative in nature. The primary data was collected from the MRAS located on the compound of the SIDC. The production data from delivery of the animals to the end of the cycle was recorded by the technical staff. The type of data collected are daily water quality (physical), weekly water quality data (chemical), weekly feeding regime for the different life history stages, sampling data for growth rates and harvest data.

Data was inputted into a profitability model developed using Microsoft Excel. The model incorporated many profitability analysis measures in order to compute a comprehensive economic

evaluation of the MRAS system. Sensitivity analysis was performed on the model as some factors are highly variable in determining the profitability of the venture. Other types of information such as personal experience was used.

5 RESULTS

5.1 Marketing survey

The marketing survey collected data on the restaurant industry for farm-raised shrimp. The data was derived from restaurants consisting of 4 main segments. A total of 40 restaurants were selected to be surveyed (Appendix 3). The survey assisted in identifying whether farm-raised shrimp can be marketed to the restaurants, what type of restaurants, size preference, price, demand, acceptability, satisfaction and how the farmed-raised shrimp compared to wild caught shrimp. A compilation of the data can be found below describing the market scenario for farm-raised shrimp representative of all the restaurants. A more detailed analysis of the marketing survey for all restaurants can be found in Appendix 4.

The fine dining and fast food segments accounted for 27% of the survey followed by casual dining accounting for 24% and sushi accounting for 21% (Figure 2).

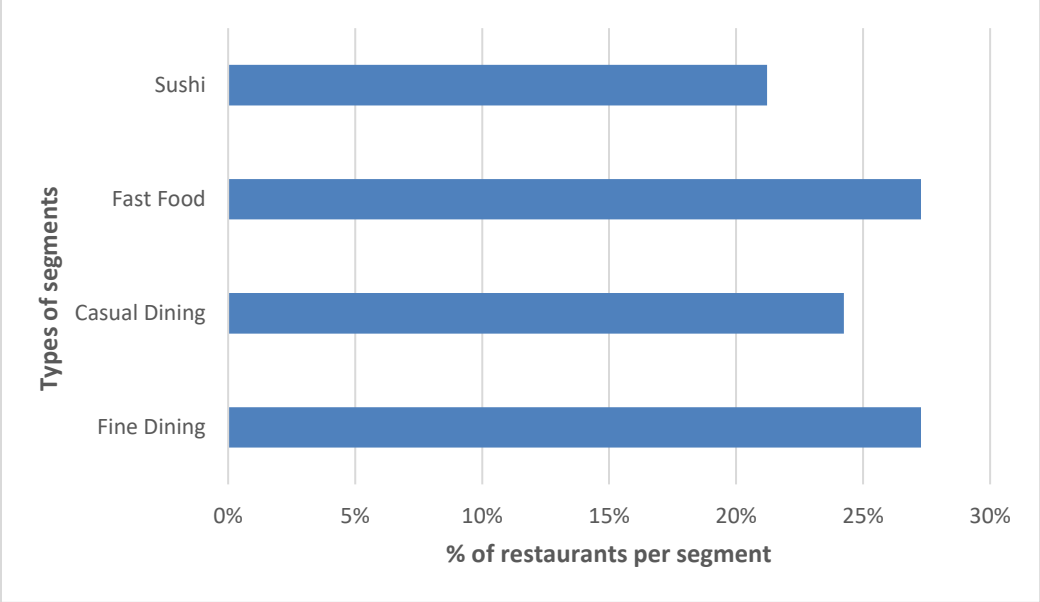

Figure 2: Total % of restaurants per segment in survey

Most of the restaurants were located in the suburban area accounting for 73% of the survey whereas the remaining 27% of restaurants were located in an urban area (Figure 3).

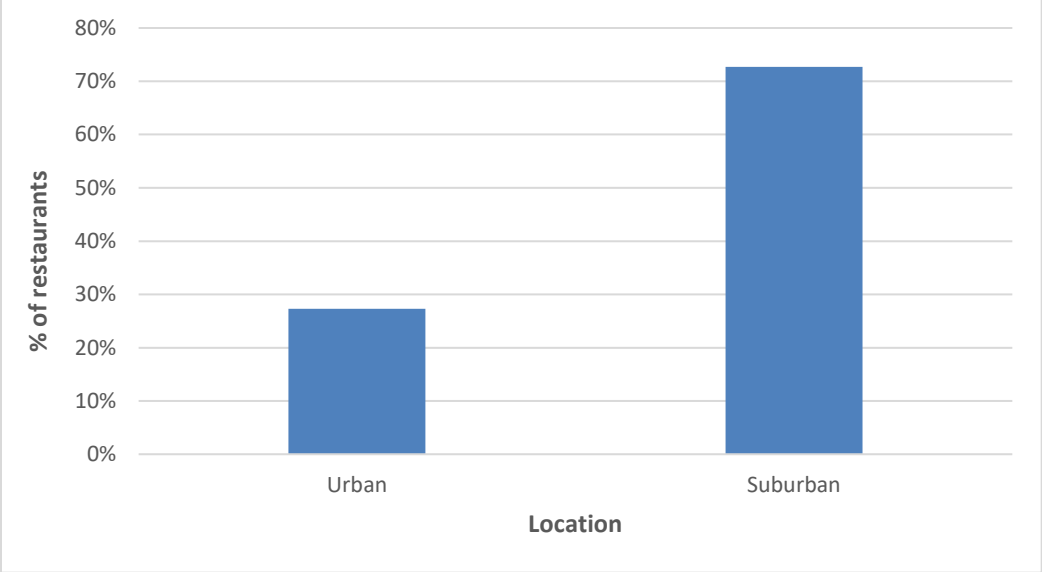

Figure 3: Total % of restaurants by location

Most of the restaurants in the survey had been in operation between 1-5 years or 42%, 33% were in operation for between 6-10 years and 24% had been in operation between 11 years to more than 20 years (Figure 4).

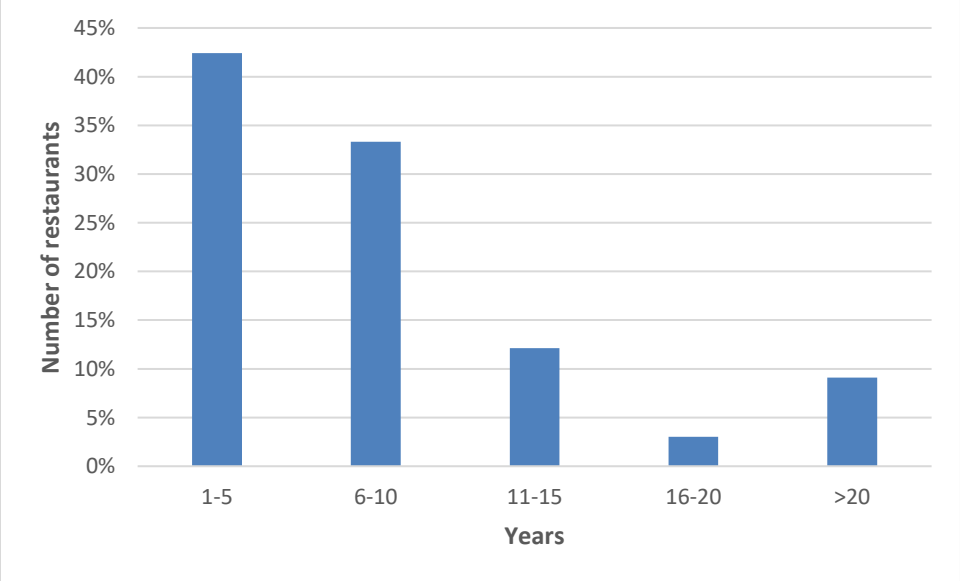

Figure 4: Total % of restaurants by years of operation

Most restaurants' primary source of seafood were from processors and the secondary source were the wholesale fish markets (Figure 5).

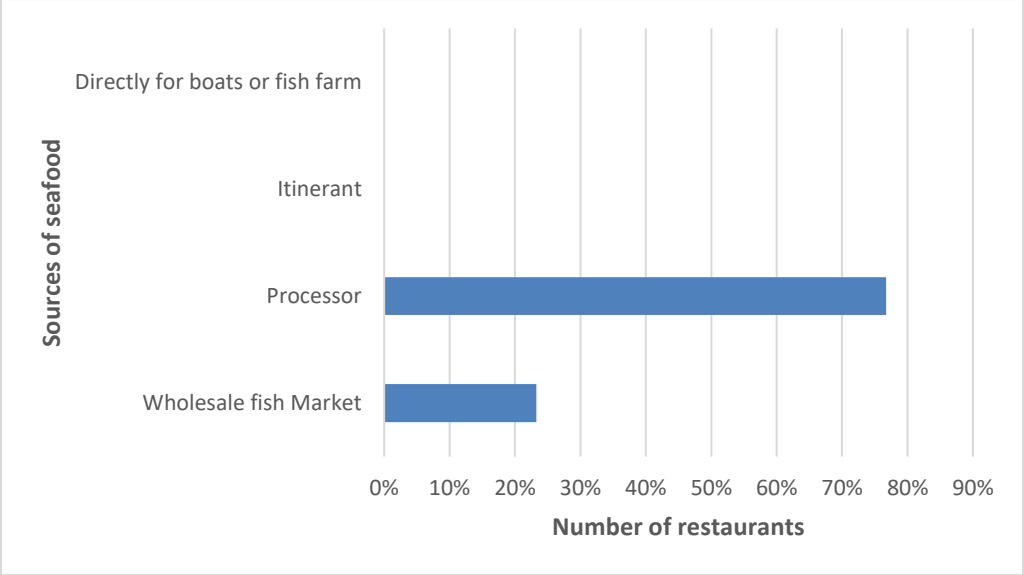

Figure 5: Sources of seafood for all restaurants

The top three preferred market forms are peeled and deveined, head-off and head-on, shell-on (As is). Other forms that were preferred were EZ peel, deveined and head-on, tail-on (Figure 6).

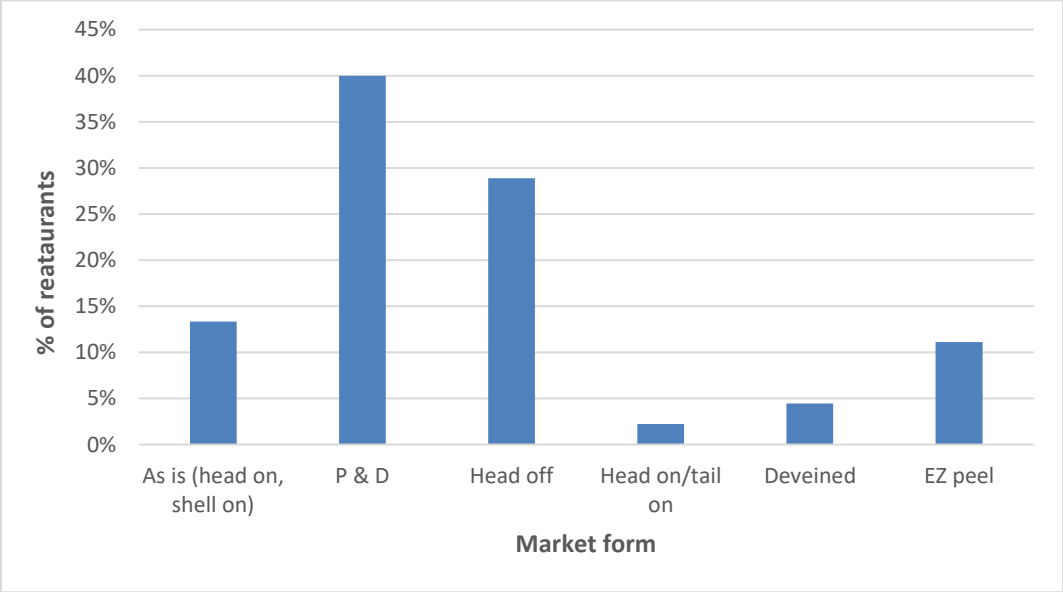

Figure 6: Preferred market forms of shrimp by restaurants

A frozen product is preferred for most of the restaurants (68%) while some preferred a fresh/chilled product (32%) (see Figure 7).

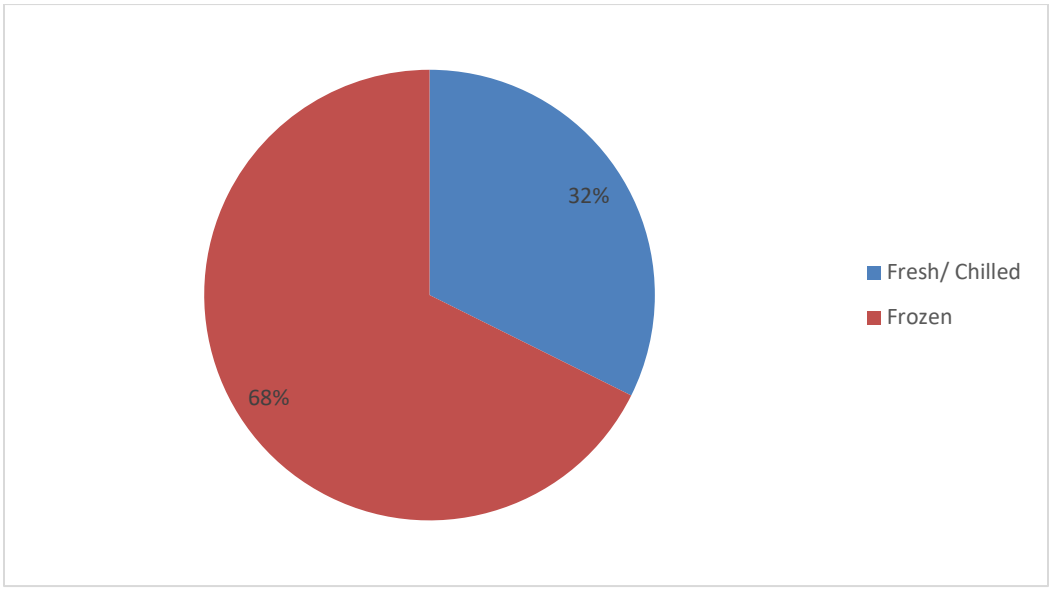

Figure 7: Type of product preferred by restaurants (fresh/chilled or frozen)

The most preferred size is between 15-25 grams per shrimp accounting for 45% of the market preference followed by 10-15 grams and 25-25 grams (Figure 8).

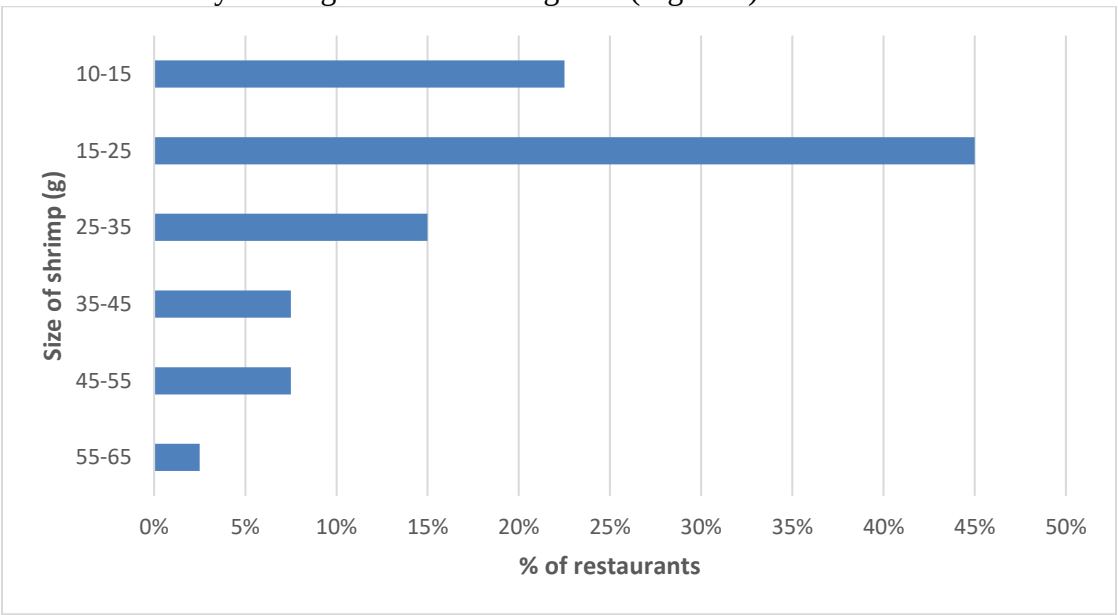

Figure 8: Size of shrimp preferred by restaurants

The most popular size of shrimp is between 15-25 grams and 25-35 grams and restaurants are willing to pay between $35-45 and $50-60 per pound (Figure 9).

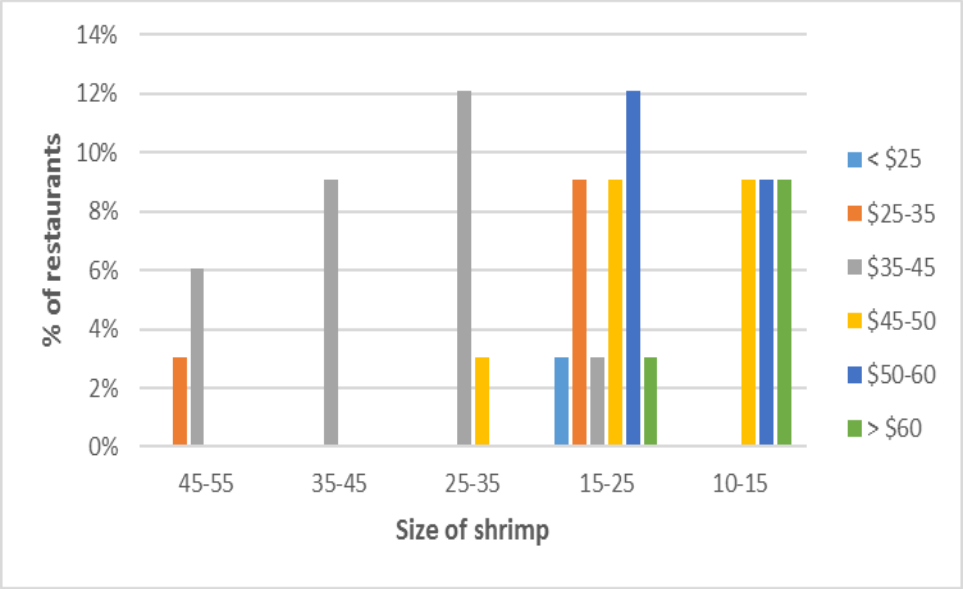

Figure 9: Price willingness to pay for different sizes of shrimp

The highest demand for shrimp is on a weekly basis followed by bi-weekly and monthly for 33 restaurants. The quantity demanded is estimated at 2,480 lbs. (1,125 kg) on a monthly basis which represents the highest quantity demanded followed by 1,860 lbs. (845 kg) weekly and 690 lbs. (313 kg) bi-weekly (Figure 10 & Table 4).

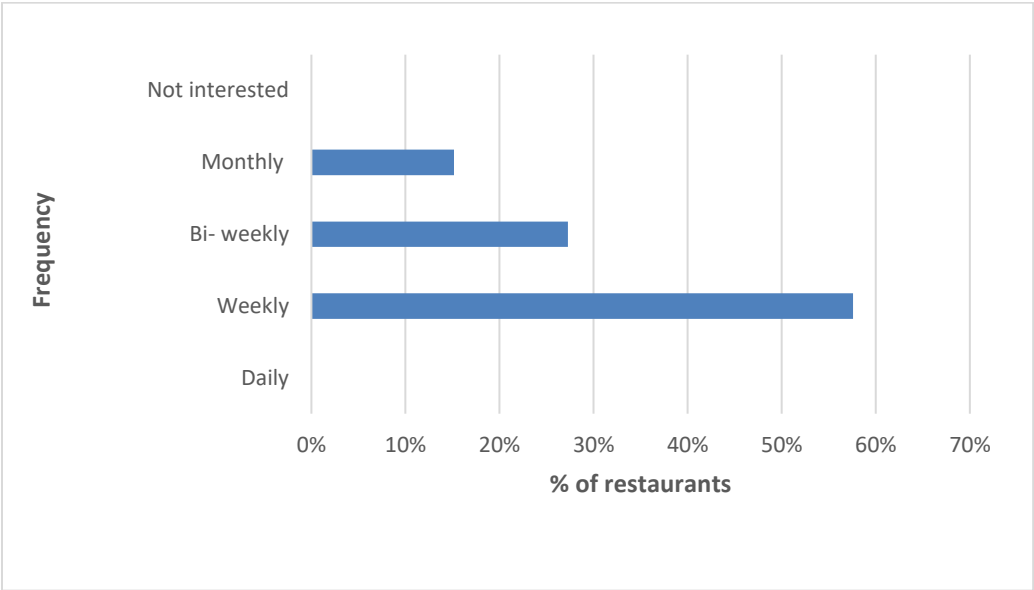

Figure 10: Frequency of shrimp required by restaurants

Table 4: Total quantity required by restaurants daily, weekly, bi-weekly and monthly

Frequency	Quantity (lbs)
Daily	0
Weekly	1860
Bi- weekly	690
Monthly	2480
Not interested	0

Restaurants liked the freshness of the shrimp the most, followed by the appearance and packaging of the shrimp. On the other hand, the colour of the shrimp was disliked the most. The freshness of the farmed shrimp is the most important quality characteristic which holds significant value for the marketing of the product that the shrimp is free from anti-biotics and locally grown. The colour of the shrimp reportedly had a blueish tint which was not accepted well by the restaurants. An explanation for this is the adaptation of the shrimp to the black production tanks or a dye in the formulated feed. It should be noted, the "off colour" is not consistent with the entire crop and has only occurred once. Most importantly it does not affect the quality attributes of the shrimp. Additionally, few restaurants indicated dislike that the shrimp was not yet available on the market (Figure 11).

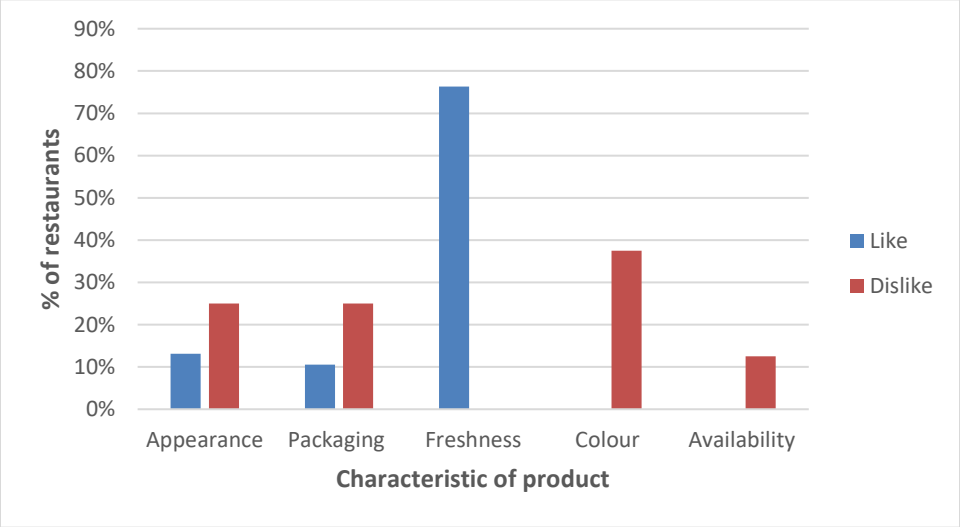

Figure 11: Characteristics of shrimp liked and disliked by the restaurants

Over 60% of the restaurants were satisfied with the farmed shrimp and 50% reported it was comparable with to wild caught shrimp (Figure 12 & 13).

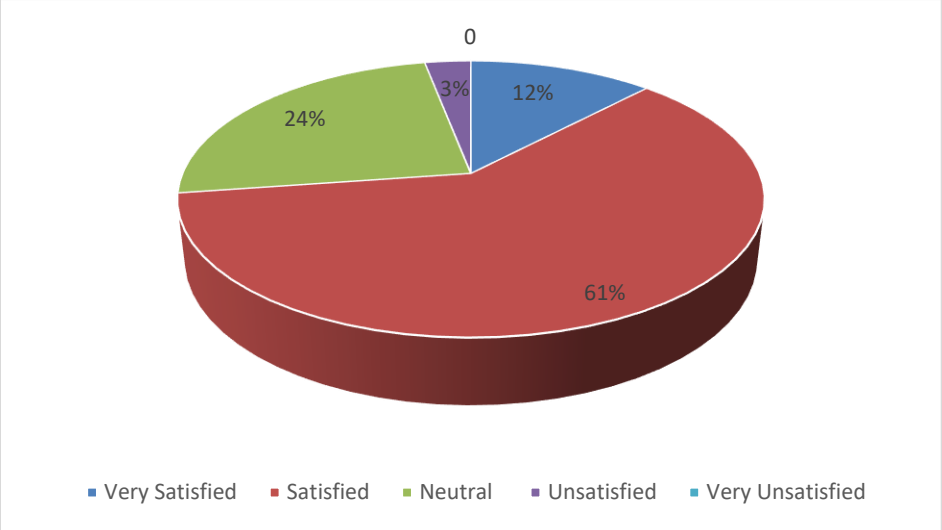

Figure 12: Satisfaction shown towards farmed-shrimp by restaurants

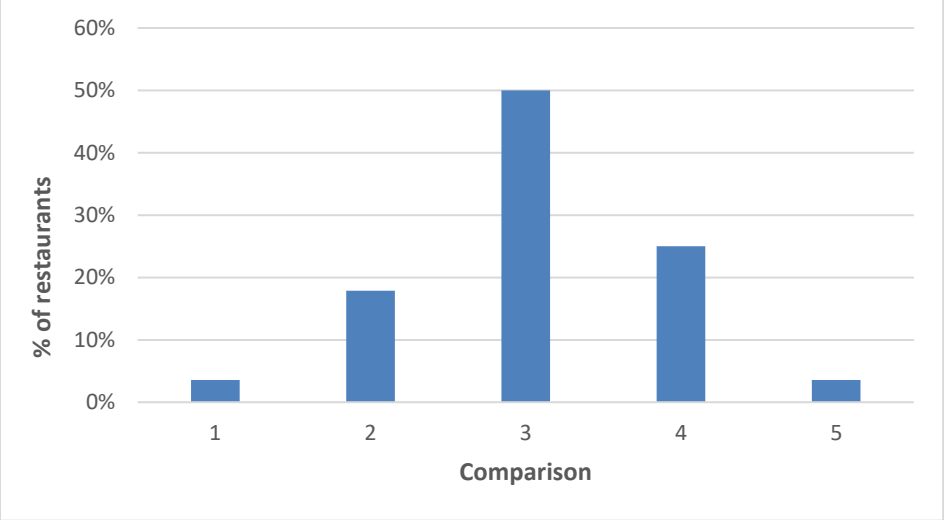

Figure 13: Comparison of farmed shrimp to wild caught shrimp by restaurants

Comments

The positive feedback highlighted the quality aspects of the shrimp (appearance, texture and flavour) as well as the size. The main concerns about the product was the blue colour of the shrimp and texture. Some other interesting comments were bigger size required, processed forms and not being comparable to sushi grade shrimp. Also, one large restaurant franchise was willing to enter into a contract for their outlet as they support the local industry (Appendix 3).

5.2 The business model for shrimp production

5.2.1 Planned production (with investment)

Shrimp post larvae 28 days old and weighing 0.25 grams were stocked in production tanks at a density of 450/m³. Based on the main assumptions in Table 1, the number of shrimp, mean body weight and total biomass was determined over a 16 week grow-out period. The shrimp were fed

manually approximately 4 to 6 times per day with the first and last feeding being a larger portion and the in-between feedings equally allocated throughout the day. The daily feed ration (DFR) is determined using weekly sampling and water quality results. The weekly sampling provides data on the average body weight and is used to estimate the average total biomass of the system. The weekly water quality results also influence the DFR if some parameters are out of the acceptable range. An estimated guideline for the daily feeding rate of shrimp is shown in Table 5.

Table 5: Guidelines feeding rate for *Litopenaeus vannamei* (SIDC)

Month	Average body weight (g)	Daily feeding ratio (%/biomass/day)
1	0 - 0.25	Ad libitum
2	3 – 4	25 – 10
3	4 – 12	10 – 3
4	12 – 20	3 – 1

The main costs incurred in the production were the cost of feed and the cost of fingerlings. All the major costs were calculated and subtracted from the revenue at the end of the cycle to yield a net profit contribution of TT $15.8 per kg (Table 6). Details of the inputs, costs, quantities (Appendix II).

Table 6: Summary of revenue, costs and net profit contribution of 148m^3 model

Revenue:		
Retail price	77	TT/KG
Sales revenue	92.4	TT 000's
Costs:		
Feed	66.6	
Post larvae	10.0	
Total costs	76.6	
Net Profit Contribution	**15.8**	TT 000's

5.2.2 Monitoring farm operations

The performance of the systems will be monitored during operations using the profitability model. This will benefit the investor as it will determine the feasibility and payback period of the investment. In the future, this measure will be used on farms to assist in planning operations and to track cash flow. It will also assist in determining if some existing aquaculture operations are profitable. For example, the profitability model can be used to track the performance of the farm and inform if the farmer is adhering to production and sales targets as projected in the model (Figure 14).

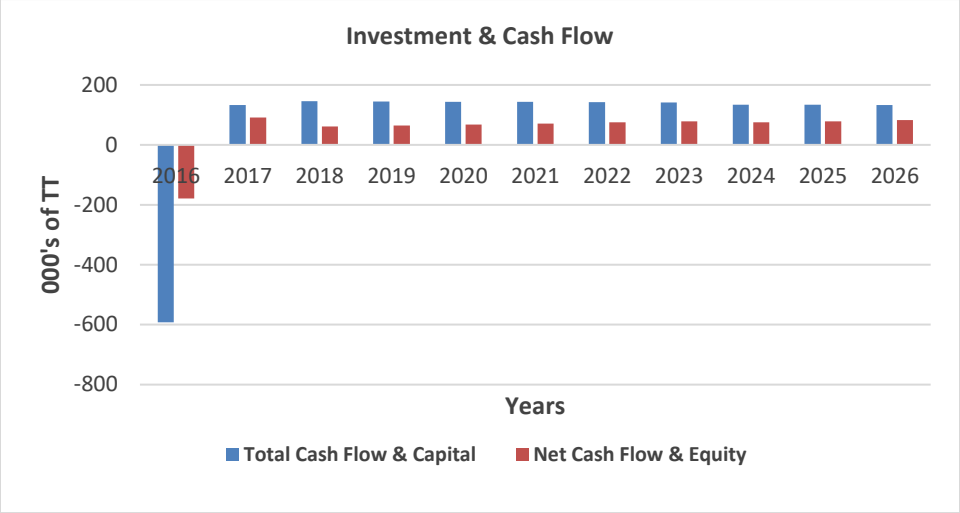

Figure 14: Investment and cash flow of 148 m³ shrimp farm over a period of 10years

5.2.3 Investment costs

When entering aquaculture or fish farming a farmer would firstly need to possess capital or cash to invest. The size of the investment would depend on the type of farming, design and facilities required for that particular venture, for example, hatchery or grow out production. The investment may be described as land, buildings, tanks, vehicles, equipment and start-up costs. Start-up costs, also known as initial costs, include those costs associated with starting a shrimp farm. Some of the items in the start-up costs include: locating suitable land, green house construction for enclosure, constructing fiberglass tanks, feed and salt storage using shipping containers, constructing an offsite office or lab, installing pumps and pipe systems for water and aeration, constructing access roads and minor equipment such as weighing scales.

Operating costs

In financial accounting, operating costs include fixed costs and variable costs. Fixed costs are costs associated with the long-term operation of a venture. For example, rent, loan payment, property tax, insurance and security. Variable costs are costs associated with the daily operations of the venture and varies with the size of the operation. For example, fingerlings/post larvae, feed, electricity, labour, chemicals and consumables. It should be noted that fixed costs should not be ignored when assessing the feasibility of an operation. Also, variable costs often increase in relation to the size of farms.

Expected returns

The returns from a shrimp farm is the money the farmer receives from the sale of the shrimp at the end of a production cycle. Profit is calculated by subtracting the costs of production from the returns or the money received from the sale of the shrimp. Returns from shrimp farming can be classified as “gross” or “net “returns and the difference of the two terms is important.

Gross returns can be defined as the money received by the farmer from the sale of the shrimp. No costs of production are included in this calculation. Gross returns can be calculated by multiplying the total harvest in kilograms by the price per kilogram received for the shrimp.

Net returns can be defined as the money remaining after all the costs of production are subtracted from the gross returns. This end figure is also called Profit. It is the measure used to determine the profitability or the economic returns of the farm (Table 7)

Table 7: Investment analysis sheet (costs of production and expected returns)

Item	**Kgs**	**Value (TTD)**
Revenue	-	-
Price	-	-
Total Harvest	-	-
Sales	-	-
Total Income	-	-
Variable costs	-	-
Salt	-	-
Post larvae/fingerlings	-	-
Live feed	-	-
Formulated feed	-	-
Labour	-	-
Water quality test kits:	-	-
Total ammonia	-	-
Nitrites	-	-
Nitrates	-	-
Chlorine	-	-
Sodium bicarbonate	-	-
Oxygen	-	-
Alcohol	-	-
Bleach	-	-
Bio clean	-	-
Total Variable costs	-	-
Fixed costs	-	-
Rent/Lease	-	-
Salaries	-	-
Security	-	-
Utilities	-	-
Total costs	-	-
Net farm income	-	-
-	-	-

5.2.4 Risk assessment and sensitivity analysis

Risk assessment and sensitivity analysis will be used to provide additional understanding into the overall feasibility of the operation.

Risk assessment

NPV and IRR were used to assess the profitability of the farm. The NPV is equal to the present value of future net cash flows, discounted at marginal average rate of return (MARR). The NPV, calculated at a 15% interest rate greater than the IRR (19%) was greater than the MARR (15%) indicating that the venture is feasible. The planning horizon of the venture is 10 years (with a payback period expected number of years required to recover the cost of the investment) of 6 years (Figure 15). In six years the investors equity will be repaid and in 10 years the loan will be repaid. The long payback period is considered normal for aquaculture ventures and implies some degree of risk is involved in these ventures.

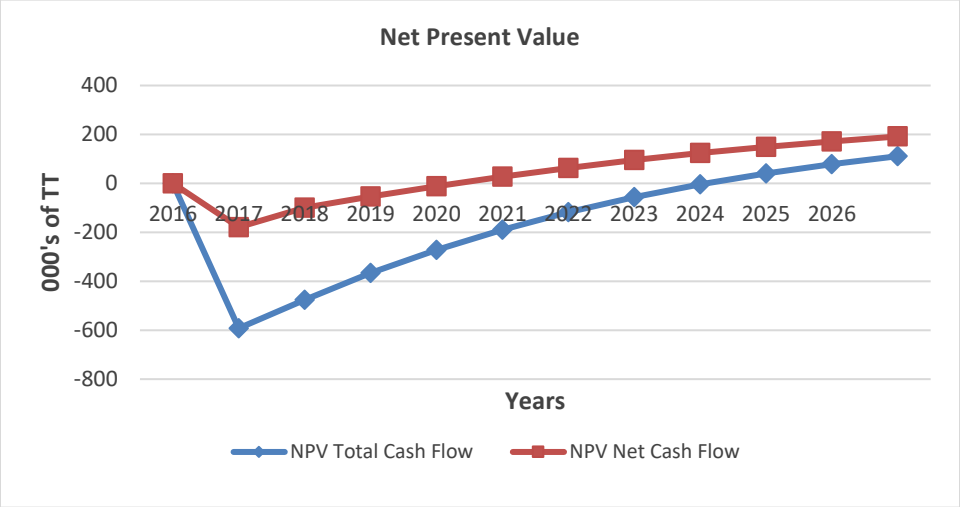

Figure 15: NPV of shrimp farm model

The IRR is the discount rate that equates the present value of the project's expected cash inflows to the present value of the project's cost. The IRR on a project is its expected rate of return. If the internal rate of return exceeds the cost of the funds used to finance the project, a surplus remains after paying for the capital, and this surplus accrues to the farmer. The IRR for the 148m³ farm was greater than the MARR. It becomes positive from year 6 (6%) and rises above the discount rate of 15% from year 9 (17%) meaning the venture is profitable to operate over the planning horizon is 10 years (Figure 16).

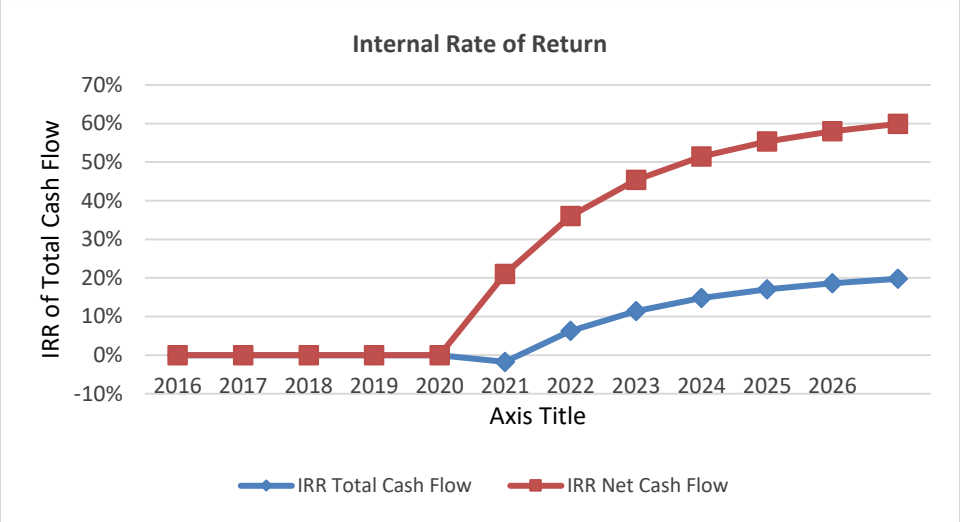

Figure 16: IRR of the shrimp farm model

A debt service coverage ratio of above one indicates that there is enough cash to pay interest and repayment of loans. A net current ratio of above one indicates that current assets are greater than current liabilities. Both the debt service coverage ratio and the net current ratio were above one (Figure 17). It should be noted that both ratios become positive after year 2 due to high initial start-up costs but both increases high above the required ratio into year 3.

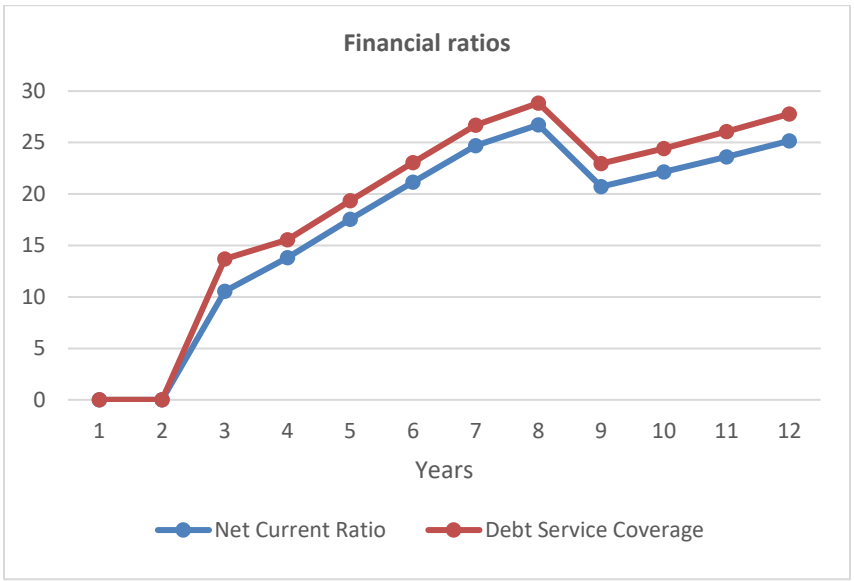

Figure 17: Financial ratios of the shrimp model

Sensitivity analysis

The profitability of the fish farming investment is most sensitive to the production and sales price of the shrimp (Figure 18). It should be noted that a 10% decrease in sales price results in an IRR under the MARR which is not acceptable.

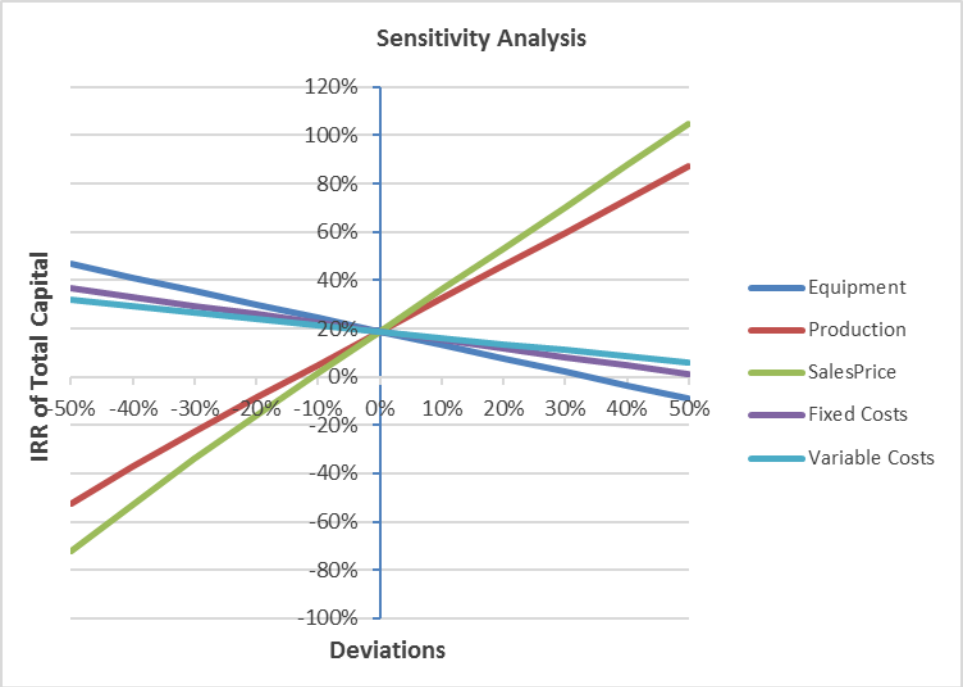

Figure 18: Sensitivity analysis of equipment, production, price, fixed costs and variable costs

6 DISCUSSION

Based on the marketing survey, farm-raised Pacific white shrimp could be marketed to restaurants in Trinidad. The restaurant industry shows a great level of satisfaction to the farm-raised shrimp which displays to acceptance for the farm-raised shrimp. A 50% neutral comparison rate suggests that restaurants consider the farm-raised shrimp and wild caught shrimp share similar characteristics and they are impartial to either product. Thus, farm-raised shrimp can be substituted for wild caught shrimp or is interchangeable for their operations.

The largest segments were the fine dining and the fast food segments followed by the casual dining and Sushi. Most of the restaurants are in suburban areas. The location of the restaurant is important as it would affect the logistics and planning for farm operations and who is the target this market. Most of the restaurants have been in operation for less than 10 years old. This suggests that there is an increasing number of new entrants into the restaurant industry more specifically in fine dining and the sushi business. Fast foods and casual dining has been in operation for the longest. This scenario describes increasing demand and a stable market for the sale of the farm-raised shrimp.

The seafood processors hold the majority share of the restaurant market (77%) and the wholesale market supplements the remaining 23%. The type of product preferred by the restaurants is frozen while some restaurants preferred fresh/chilled. In terms of market form, the market requires mostly peeled and deveined followed by head-off. This suggests that there is a market for fresh/chilled shrimp, but partial processing of the shrimp is required to meet customer

requirements. It should be noted that there still exists a small market for whole shrimp (head-on, shell-on).

The most preferred size of shrimp is between 15-25 grams. This means that it takes approximately 18 to 30 whole shrimps to make one pound. This size range can be categorized into 16/20, 21/25 or 26/30 count falling into the medium to large size shrimp category. The most popular sizes of shrimp used is between 15-25 grams and 25-35 grams and restaurants are willing to pay between $35-45 and 50-60 per pound. In terms of production, a current production cycle of the system is 16 weeks and an average body weight achieved is 20 grams or more.

In terms of the size of the product, all market segments (Fine dining, Chinese, Causal and Sushi) require a medium shrimp (16/20 – P& D). The survey also revealed the following trend requirements within the categories:

- Fine Dining - large to jumbo product (10/15 and 16/20)
- Casual – medium product (16/20 and 25/35)
- Sushi –large to jumbo product (16/20 and 10/15)
- Chinese – Jumbo to medium to small product (16/20 and 45/55)

From the responses of the questionnaire the price restaurants were willing to pay was linked with the size of the product as well as the market segment. Fine Dining restaurants were willing to pay more for a larger product. This category was willing to pay between fifty and sixty or more than sixty dollars ($45-60, >$60) for a 10/15 and 16/20 product. Both Casual dining and Sushi were willing to purchase the 16/20 count for between forty-five and sixty dollars ($45-$60) per pound. Chinese restaurants on the other hand were only willing to purchase between twenty-five and forty dollars ($25-$45) per pound for the 16/20 count.

Approximately 60% of the 33 restaurants who took part in the survey prefer a weekly supply of shrimp for their operations primarily to ensure fresh high-quality shrimp is always available as well as to minimize inventory and storage costs. The weekly quantity is also the second highest quantity demanded overall at approximately 845 kg. Bi-weekly is the lowest quantity demanded at 313 kg, but it is the second highest demand frequency. The monthly demand is the highest at 1,125 kg.

Restaurants were most impressed by the freshness of the farm-raised shrimp although the market uses mostly a frozen product. The frozen product is consistent with the demand frequency which is mostly weekly as mentioned earlier. The quantity required varied by segment with the casual dining segment purchasing the most shrimp on a weekly basis and fast food segment purchasing the most on a weekly basis.

The colour of the shrimp reportedly had a blueish tint which was not accepted by the restaurants. An explanation for this is the adaptation of the shrimp to the production tanks or a dye in the formulated feed. It should be noted, the “off colour” is not consistent with the entire crop and has only occurred once. Most importantly it does not affect the quality attributes of the shrimp. Additionally, few restaurants indicated dislike that the shrimp was not yet available on the market.

It may be pertinent to indicate that some restaurants were ready to purchase the product and were interested in the price and the time frame in which the product will be available on the market. One restaurant (Ruby Tuesday's) is interested in commencing a contractual agreement for the SIDC to supply the chain on a monthly basis.

The main results from the marketing survey was then inputted into a profitability model. The purpose of the profitability model is to assess the feasibility of shrimp farming using a marine recirculating aquaculture system (MRAS) in Trinidad. The market survey was conducted to strengthen the data and assumptions inputted in the profitability model. It is expected that the model will be used as an assessment tool to provide valuable information to farmers and investors to promote a more market-driven approach to aquaculture farming. The results generated from the model will equip potential investors, existing farmers, government, financing institutions and other stakeholders in the seafood sector with the knowledge to determine the profitability of existing farming operations and the feasibility of other projects to reduce failure or failure to repay loans.

Using the MRAS in Trinidad as a case study, a profitability model was developed and used to assess its feasibility in the production of the Pacific white shrimp. It is imperative for investors, farmers and stakeholders to know how much capital is required to invest into shrimp farming. Not only a clear figure of how much capital is needed but also what is the return on this capital or profit. In shrimp farming land, buildings, equipment, feed, post larvae and labour are all crucial elements needed to produce shrimp on land. The amount of capital, type of equipment and type of production system determines the outlay.

The study estimated TTD $723,000 is required to start commercial shrimp farming. This includes the construction of a greenhouse of approximately 10,000 sq. ft., the purchase of a vehicle for transportation, the purchase of equipment, plumbing, electrical, water storage, water quality lab, feed storage, salt storage and an office. The venture was financed through 30% owner's equity and 70% loans. It should be noted that the cost of feed, post larvae and salt are the highest in the production costs (Appendix 3).

These three items are not available or produced locally and therefore must be imported. High exchange rates, taxes and duties, and transportation costs contribute to the costs of the items increasing production costs. The conception of a hatchery to produce post larvae locally, competitive prices for good quality feed and salt and higher economies of scale would make the investment more profitable or more attractive. The operation was very sensitive to changes in production and sales price. A 10% decrease in these two factors would result in a lower IRR of total capital. For example, a 10% increase in production costs or a 10% decrease on sales price would result in a lower IRR under 15% which is unacceptable for the investment (Figure 18). The annual production figures from the study for a production capacity of 148/m^3 is approximately 3 tonnes. This production capacity is made up of the two systems: MRAS 1 and MRAS 2. The planned production is comprised of 3 cycles at 16 weeks/cycle. For example, there are 52 weeks in one calendar year which would yield 3 cycles of shrimp/year. There is one-week downtime at the end of each cycle to allow for cleaning and sanitization of MRAS 1 in preparation for the next batch of post larvae. This system will be used as quarantine for each new batch of shrimp. The process will be repeated 3 times until the third cycle is harvested. The

remaining 2 weeks in the year will be used to clean, sanitize, perform repairs and maintenance on both systems. The average number of cycles is 3 cycles/ year.

The interesting circumstances about this model is that both systems are in operation but for research purposes. Therefore, it is safe to conclude the management of the system and how to culture the specie is learnt. The model yields are estimated at 1 ton per cycle 3 times per year totalling 3 tons. Operating at this capacity the indoor farm can generate an income of TTD $35,000.00 for first year of operation and TTD $45,000.00 in the fifth year of operation. The cash flow of operations over a ten-year period is shown in Figure 18 and Appendix 5.
The profitability model was also useful to determine if the venture was feasible by using financial indicators such as payback period, NPV and IRR. The NPV was positive, implying that the venture is feasible. The payback period which is the expected number of years required to recover the cost of the investment was 6 years (Figure 19). An NPV of zero signifies that the project's cash flow is sufficient to repay the invested capital as well as provide an acceptable rate of return on that capital. In this case, the project has a positive NPV which means it is generating more cash than is needed to service its debt and provide the required return to investors. The IRR for the farm was above a minimum set percentage called the marginal attractive rate of return (MARR), meaning the venture is profitable to operate (Figure 20).

The debt service coverage ratio was below 1 for the first two years but increased above 1.5 showing that the cash flow from the operation was well above the repayment and interest of loans, which must be paid. The net current ratio was also below 1 but then increased above one, meaning the current assets were not less than current liabilities, therefore the investment is acceptable (Figure 9). However, an increase in operating cash flow or debt facility maybe be needed to ensure a smooth flow of operations.

Currently, the interest rate on loans for aquaculture ventures are 5.5% on the reducing balance. The farmer can only earn his money back after 6 years (Figure 19). Also, the capital requirements for the grow-out systems may be beyond the financial means of many small producers. Further, given the huge initial capital outlay for investment of at least TTD $723,000 (USD $107,000) for a 148 m^3 farm, there is a great need for the government and financial institutions to make loans easier for farmers to qualify, adjust rates or create other incentives to fish farmers and those who may want to invest in the industry.

Based on the production model assumptions and the analysis of the profitability model, shrimp farming appears feasible and profitable in Trinidad. However, for a sustainable development of the industry, the government, farmers and other stakeholders are challenged with the responsibility of planning and conducting aquaculture development whereby social, environmental and economic goals are can be achieved.

It should be noted the model does not fully consider all the uncertainties and risks associated with shrimp production. This is of great importance as if the risks are not identified and given sufficient attention the crop can be lost leading to failure of the venture. In the future, a risk analysis should be conducted to improve the management of the farm hence, reducing losses and protecting the farmer's investment.

7 CONCLUSION

A profitability model was developed to assess the feasibility of operating the system to produce shrimp in Trinidad. The intention of the model is that it will be used by existing farmers practicing aquaculture to better assess aquaculture ventures and improve operations as well as by interested farmers, investors, entrepreneurs, government, financial institutions and stakeholders. Key assumptions were made based on production and market forces. Information to support the assumptions used in the model was collected by conducting a market survey. The survey provided information such as target segments, price, demand, size, acceptability of farm-raised shrimp, satisfaction of the quality and comparison to existing wild caught shrimp. The survey revealed there is a potential for the SIDC's farmed shrimp to enter the local market, however for the venture to be successful additional processing will be required. The survey also reflected restaurants were willing to pay an average price of TTD $35/lb ($77/kg) of fresh shrimp.
The results also showed trends within the identified segments which allows for the opportunity of niche marketing of the product. Based on the volume of shrimp produced or the capacity of the system, production can be tailored to meet market requirements at a price where it is profitable, and sales can be targeted towards the various market segments to maximize profits.

From the case study of shrimp farming using a marine recirculating aquaculture system (MRAS) in Trinidad the results are that shrimp farming is profitable. An estimated investment of $723,000 (USD $107,000) is required to invest in the venture which will be repaid over a ten-year period. This period is the standard investment period for aquaculture ventures of a commercial scale. The NPV was positive and the IRR was above the MARR.

The debt service ratios are all above 1.5 display that the cash flow is sufficient to cover operating expenses as they become due. The sensitivity analysis displays the venture is sensitive to production and price changes.

The SIDC indoor marine recirculating aquaculture system (MRAS) is one approach to supplementing or reducing the food import bill for shrimp in Trinidad. Most of the restaurants' supply comes from the seafood processors, they hold most of the share of the seafood supply market with the wholesale market holding the smaller share. More significantly it is important to note the potential to expand the aquaculture industry in Trinidad by doing proper market research and better organization the industry. Once aquaculture become feasible the industry can better develop and supply a greater share of the seafood locally.

Also, in the future exporting of the farmed-shrimp can be explored due to the relatively low volume and high-quality shrimp to niche markets whilst earning foreign exchange. The steps forward would be to focus on the assessment of existing aquaculture projects and ensure it is operating profitable. This would allow the farmer to generate returns to reinvest and expand his business and therefore fuel growth in the industry. Also, a hatchery should be set up to provide post larvae to the grow outs. This will make the production more sustainable as well as provide vertical integration of the industry as currently the post larvae are imported. To conclude, the model can be adapted to assess any type of aquaculture project with respect to freshwater culture or another species.

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Appendix 1: Marketing questionnaire

SEAFOOD INDUSTRY DEVELOPMENT COMPANY LIMITED
#6 BEJUCAL EXTENSION #1,
URIAH BUTLER HIGHWAY,
CHARLIEVILLE, TRINIDAD & TOBAGO
WEST INDIES
Tel: 868-665-0751, Ext. 238 Fax: 868-671-8932 E-mail: kslinger@sidctt.com

Marketing Survey on the willingness to purchase Farm-raised Shrimp January 2017

Dear Sir/Madame,
The Seafood Industry Development Company Limited (SIDC) would like your participation in a survey to obtain your views about the acceptance of aquaculture products and your willingness to pay for these products once produced locally. The objective of the survey is primarily to support the research efforts of the company and for the greater development of the Aquaculture Industry in Trinidad and Tobago. **Your responses will be held in the strictest confidence. All results will be tallied together and reported as a group response. Individual responses would NOT be identified.**

Date: Surveyor: Restaurant:

Part A: General Information

1. How many years have you been in operation? _____
   - ○ 1-5
   - ○ 6-10
   - ○ 11-15
   - ○ 16-20
   - ○ >20

2. Is your food service operation located in an/a _____?
   - ○ Urban setting
   - ○ Suburban setting
   - ○ Rural setting
   - ○ Community

3. What type of restaurant is it?
    - ○ Formal dining (white table cloth)
    - ○ Casual dining
    - ○ Fast food
    - ○ Sushi

4. What type of seafood product/s do you currently purchase?
    - ○ Fin Fish
    - ○ Shell Fish
    - ○ Both

5. Where do you purchase the majority of your seafood?
    - ○ Wholesale fish market
    - ○ Processor
    - ○ Itinerant vendor
    - ○ Directly from boats or fish farmer

Part B: Product

6. How satisfied were you with the product?
    - ○ Very satisfied
    - ○ Satisfied
    - ○ Neutral
    - ○ Unsatisfied
    - ○ Very unsatisfied

7. How did you prepare the shrimp?
    - ○ Fried
    - ○ Baked
    - ○ Curried
    - ○ Stir-fry
    - ○ Steamed
    - ○ Raw
    - ○ Other _____

8. What did you like most about the product?

- ○ Appearance
- ○ Freshness
- ○ Packaging
- ○ Other _____

9. What did you like least about the product?
   - ○ Appearance
   - ○ Freshness
   - ○ Packaging
   - ○ Other _____

10. What would make the product better?
    - ○ Partial processing
    - ○ Improved packaging
    - ○ Other _____

Part C: Pricing

11. What size of shrimp do you prefer? (number of shrimp per pound)
    - ○ 55-65
    - ○ 45-55
    - ○ 35-45
    - ○ 25-35
    - ○ 15-25
    - ○ 10-15

12. How much are you willing to pay for the above mentioned sizes whole (head on/shell on) shrimp?
    - ○ 55-65 ( )<$25 ( )$25-$35 ( )$35-$45 ( )$45-$50 ( )$50-$60 ( )>$60
    - ○ 45-55 ( )<$25 ( )$25-$35 ( )$35-$45 ( )$45-$50 ( )$50-$60 ( )>$60
    - ○ 35-45 ( )<$25 ( )$25-$35 ( )$35-$45 ( )$45-$50 ( )$50-$60 ( )>$60
    - ○ 25-35 ( )<$25 ( )$25-$35 ( )$35-$45 ( )$45-$50 ( )$50-$60 ( )>$60
    - ○ 15-25 ( )<$25 ( )$25-$35 ( )$35-$45 ( )$45-$50 ( )$50-$60 ( )>$60
    - ○ 10-15 ( )<$25 ( )$25-$35 ( )$35-$45 ( )$45-$50 ( )$50-$60 ( )>$60

Part D: Market

13. Do you ever use aquaculture (farm-raised) products?
    - ○ Yes
    - ○ No If No go to Question 21

14. If so, which products?
    - ○ Farm raised shrimp
    - ○ Farm raised Salmon
    - ○ Farm raised oysters
    - ○ Farm raised mussels
    - ○ Tilapia
    - ○ Catfish
    - ○ Other ……

15. Do you see any advantages of aquaculture products compared to wild caught products?
    - ○ Consistent quality
    - ○ Consistent supply
    - ○ Consistent price
    - ○ Consistent size (portion control)
    - ○ Food safety
    - ○ Better shelf life
    - ○ All of the Above

16. Do you include the term “Farm raised” or “Aquaculture” on your menu as a marketing tool?
    - ○ Yes
    - ○ No

17. Would you purchase farm-raised shrimp?
    - ○ Yes
    - ○ No

18. How frequently would you be willing to purchase Farm-raised shrimp?
    - ○ Daily _____ lb
    - ○ Weekly _____ lb
    - ○ Bi-weekly _____ lb
    - ○ Monthly _____ lb

○ Not interested

Please give reason why

…….

19. What type of product do you prefer?
    - ○ Fresh/chilled
    - ○ Frozen
20. What market form do you prefer?
    - ○ As-is (head-on, shell-on
    - ○ Peeled
    - ○ Peeled and deveined
    - ○ Head-off
    - ○ Head-off, tail-off
    - ○ Other
21. Using the scale 1-5 with 1 being not comparable and 5 highly comparable. How do you compare this product with a wild caught product?

    1 2 3 4 5

Thank you for your assistance!

…….

Appendix 2: List of all restaurants from all groups (fine dining, casual dining, fast food and sushi)

No.	Restaurants	Returned questionnaires
1	360° Restaurant	✓
2	Aioli	✓
3	Aquarium	✓
4	Asian Buffet	✓
5	Asian Fusion	✓
6	Bootleggers	✓
7	Buffet King	✓
8	Buzo Osteria	✓
9	Casa	✓
10	Castro's	✓
11	Chaud	✓
12	Dim Sum King	✓
13	Eurasia	✓
14	Hakka	✓
15	Hyatt (Sushi Bar)	✓
16	Kaizan	✓
17	Kam Wah	Did not utilize product to date
18	Krave	✓
19	Luce	✓
20	Melange	Product not delivered
21	More Sushi	✓
22	Mr. Rango's	✓
23	Potionz	✓
24	Restaurants	Returned questionnaires
25	Rising Star	✓
26	Ruby Tuesday's	✓
27	Rustica	✓
28	Sakura Arts	Did not utilize product to date
29	Samurai	✓
30	Silhouettes	✓
31	Soong's Great Wall	✓
32	Sushi Express	✓
33	Texas de Brazil	✓
34	The Rig	✓
35	The Rise	✓
36	Touch & Taste	Did not utilize product to date
37	Town	No feedback
38	Trotters	✓
39	Valpark Chinese	✓
40	Vayberri on the greens	✓

Appendix 3: Summary of comments from all the restaurants in the survey

Positive comments:

- Like the product
- Shrimp juicy and not hard
- Very good, stored for 3 days cooked and was still good quality
- Please with appearance of product will buy as is with good price
- Nice texture when prepared as pepper shrimp
- Good size
- Liked appearance and quality
- Size good but used to cleaned product
- Supports local industry and willing to enter into supply contract

Negative comments:

- Why is it blue
- Fresh product kill what we are looking for
- Did not like blue colour
- Colour was off (blue). Customers sceptical about colour. Asked if new species.
- Product rubbery and did not like colour
- Did not taste fresh
- Lacked flavour
- Concerns about colour
- Colour disappointment
- Colour major deterrent. Asked if spoilt.

Other:

- Bigger size but good price
- Bigger size
- Product appeared different from wild caught used for sushi (nobashi grade)
- Offer cleaned with increase in price

Appendix 4: Detailed marketing analysis of all restaurant segments

Marketing survey

Fine dining

Years in operation
Survey respondents were asked how many years their current business had been in operation. Four restaurants responded between 1 – 5 years and four responded 6 – 10 years. One restaurant responded between 11 – 15 years. One restaurant did not respond.

Location of operation
Three restaurants indicated their location is situated in an urban setting and six responded their location is situated in a suburban setting. One restaurant did not respond.

Types of seafood purchased
Nine restaurants indicated that they purchased both finfish and shellfish. One restaurant did not respond.

Sources of seafood
Nine responded they acquire their seafood from processors and five responded they acquired their seafood directly from the wholesale fish market. None reported acquiring their seafood directly from boats, fish farms or itinerant vendors.

Price
Respondents indicated they will purchase the required sizes for thirty-five dollars and over (≥$35.00). For the 10/15 count, two respondents indicated their willingness to pay between forty-five and fifty dollars ($45-50), two between fifty and sixty dollars ($50-60) and two above sixty dollars (≥$60). For the 15/25 count one indicated over sixty dollars (>$60) and for 35/45 count one between thirty-five and forty-five dollars ($35-45) (See Figure 3).

Size requirement
Respondents did not respond to the size requirement for a head on/ shell on product, instead they responded to a head off/ shell off product which is currently available on the market. Restaurants indicated more than one size requirements in this category. The majority indicated they preferred a larger product (head off/shell off) to the sample delivered. Six respondents preferred a 10/15 count, three a 15/25 count, one a 25/35 count, one at 35/45 and one a 55-65 count.

Frequency and quantity
Five restaurants responded they will purchase products weekly, two bi-weekly and two monthly. The quantity required by restaurants varied. Table 8 provides a breakdown of the average quantity.

Table 8: Quantity of Shrimp required by Fine Dining Restaurants

Frequency	Average (lbs)
Weekly	150
Bi-weekly	140
Monthly	320

Market type and market form

Five restaurants indicated they would prefer a frozen product and four a fresh product. In terms of the market form, seven responded they preferred a Peeled and De-veined product, two a head off product and one indicated "as is" (head on, shell on).

Method of preparation

Restaurants utilized various methods in the preparation of the samples. Two restaurants utilized more than one method. Three restaurants sautéed, three stir-fried, two curried, one jerk and one grilled the product.

Acceptance/Satisfaction/Suggestions

A higher number of respondents in this category were satisfied with the product. Two responded very satisfied, six responded satisfied and one responded neutral. None of the respondents were unsatisfied with the product.

Nine respondents indicated that they like the freshness of the product the most whilst two indicated appearances. One restaurant indicated the packaging of the product. Nine restaurants did not respond to not liking the product as it was not available on the market.

Eight restaurants did not respond to the question on suggestions for improvements. One restaurant indicated better packaging and one restaurant indicated a larger size.

Aquaculture products

Nine respondents indicated that they already use aquaculture or farm-raised products. Nine responded use of farm-raised shrimp, four responded use of farm-raised salmon, one responded use of farm-raised oyster and three responded use of tilapia. One did not respond.

Respondents were also asked to indicate the benefits farm-raised products provide to their operations. Nine responded to all of the listed benefits. One did not respond. In terms of respondents' willingness to purchase farm-raised products, nine responded they will purchase farm-raised products for their operations. One did not respond.

Eight restaurants indicated that they do not use the terms aquaculture or farm-raised as a marketing tool on their menus, whereas two did not respond.

Respondents were asked to compare the farm-raised product to wild caught product on a scale of 1 to 5. Four evaluated the product at a scale of 3, two at a scale of 4 and one at a scale of 2. One did not respond.

Casual dining

Years in operation
Survey respondents were asked how many years their business has been in operation. Four restaurants responded between 1 – 5 years and four responded 6 – 10 years. One restaurant responded between 11 – 15 years. One restaurant did not respond.

Location of operation
Two restaurants indicated their location is situated in an urban setting and seven responded their location is situated in a suburban setting. One restaurant did not respond.

Types of seafood purchased
Respondents were asked what types of seafood purchased for their operations. A total of eight restaurants responded both finfish and shellfish. Two restaurants did not respond.

Sources of seafood
Respondents were asked to identify how they acquired their seafood from various sources. Eight responded they acquired their seafood from processors and two did not respond. None reported acquiring their seafood directly from boats, fish farms or itinerant vendors.

Price
Respondents indicated they will purchase the required sizes for forty-five dollars and over (≥$45.00). For the 10/15 count, three restaurants indicated their willingness to pay between fifty and sixty dollars ($50-60), two between forty-five and fifty dollars ($45-50) and two above sixty dollars (≥$60). For the 15/25 count one indicated over sixty dollars (>$60). Figure 4 is a graphical representation of the 10/15 count (See Figure 6).

Size requirement
Respondents did not respond to the size requirement for a head on/ shell on product, instead they responded to a head off/ shell off product which is currently available on the market. Restaurants indicated more than one size requirements in this category. The majority indicated they preferred a larger product (head off/shell off) to the sample delivered. Six respondents preferred a 10/15 count, three a 15/25 count, one a 25/35 count, one at 35/45 and one a 55-65 count.

Frequency and quantity
Five responded they will purchase products weekly, two bi-weekly and two monthly. The quantity required by restaurants varied. Table 9 provides a breakdown of the average quantity.

Table 9:Quantity of Shrimp required by Casual Dining Restaurants

Frequency	**Average (lbs)**
Weekly	700
Bi-weekly	280
Monthly	160

Market type and market form

Six responded they would prefer a frozen product and two a fresh product. In terms of the market form, four responded they would prefer "As is" (head-on shell-on, three a head off product and two responded peeled and deveined.

Method of preparation

Restaurants utilized various methods in the preparation of the samples. Two restaurants utilized more than one method. Six steamed, three stir-fried, one fried, and one pepper the product.

Acceptance/Satisfaction/Suggestions

A higher number of respondents in this category were satisfied with the product. Five responded satisfied and three responded neutral. None of the respondents were unsatisfied with the product. Six respondents reported to like the freshness of the product the most whilst two responded the packaging. Two restaurants did not respond. One restaurant responded about the colour of the shrimp.

Eight restaurants did not respond to the question on suggestions for improvements. One responded partial processing and one responded packaging.

Aquaculture products

Respondents were asked various questions pertaining to aquaculture products. Eight responded they already use aquaculture or farm-raised products. Eight responded use of farm-raised shrimp, five responded use of tilapia, three responded use of farm-raised salmon, two responded use of farm-raised oysters. Two did not respond.

Respondents were asked to indicate the benefits farm-raised products provide to their operations. Five responded to all of the listed benefits. Three responded benefits of consistent quality, price, supply and size/portion. Two did not respond.

In terms of willingness to purchase farm-raised products, six responded they will purchase farm-raised products for their operations. Two did not respond.

Respondents were asked whether they used their terms aquaculture or farm-raised as a marketing tool on their menus, eight responded no and two did not respond.

Respondents were asked to compare the farm-raised product to wild caught product on a scale of 1 to 5. Three evaluated the product at a scale of 3, two at a scale of 4 and two at a scale of 2. Two did not respond.

Fast-food

Years in operation
Survey respondents were asked how many years their business has been in operation. One restaurants responded between 1 – 5 years, two responded 6 – 10 years, one responded restaurant responded between 11 – 15 years, one responded 16-20 years and three responded more than 20 years. Two restaurants did not respond.

Location of operation
Three restaurants indicated their location is situated in an urban setting and five responded their location is situated in a suburban setting. Two restaurants did not respond.

Types of seafood purchased
Nine restaurants indicated that they purchase both finfish and shellfish. One restaurant did not respond.

Sources of seafood
Respondents were asked to identify how they acquired their seafood from various sources. Nine responded they acquire their seafood from processors and two did not respond. None reported acquiring their seafood directly from boats, fish farms or itinerant vendors or wholesale markets.

Price
Respondents indicated they will purchase the required sizes for twenty-five dollars and over (≥$25.00). For the 10/15 count, one restaurant indicated their willingness to pay more than sixty dollars (≥$60). For the 15/25 count one indicated willingness to pay twenty-five dollars ($25), two were willing to pay between forty-five dollars and fifty dollars ($45-50). For the 25/35 count four were willing to pay between thirty-five and forty-five ($35-45) and one between forty-five and fifty dollars ($45-50).

Size requirement
Respondents did not respond to the size requirement for a head on/ shell on product, instead they responded to a head off/ shell off product which is currently available on the market. Restaurants indicated more than one size requirements in this category. The majority indicated they preferred a larger product (head off/shell off) to the sample delivered. Six respondents preferred a 15/25 count, four a 25/35 count, one a 10/15 count.

Frequency and quantity
Seven responded they will purchase products weekly, one bi-weekly and one monthly. The quantity required by restaurants varied. Table 10 below provides a breakdown of the average quantity.

Table 10:Quantity of Shrimp required by Fast-food Restaurants

Frequency	Average (lbs)
Weekly	870
Bi-weekly	20
Monthly	2000

Market type and market form

Eight responded they would prefer a frozen product and two a fresh product. In terms of the market form, five responded peeled and deveined, four responded EZ peel and deveined, two responded head-off, one responded deveined and one responded head-off/tail-on.

Method of preparation

Restaurants utilized various methods in the preparation of the samples. Two restaurants utilized more than one method. Five fried, three stir-fried, two sautéed, two pepper and one pan seared the product.

Satisfaction Acceptance/Suggestions

A higher number of respondents in this category were satisfied with the product. One responded very satisfied, five responded satisfied and two responded neutral. One did not respond. One responded unsatisfied with the product.

Eight respondents reported to like the freshness of the product the most whilst three responded the appearance. One restaurants did not respond and three restaurant responded to more than one category. Two responded they did not like the packaging.

Six restaurants responded partial processing and one responded packaging. Two did not respond.

Aquaculture products

Respondents were asked various questions pertaining to aquaculture products. Nine responded they already use aquaculture or farm-raised products. Nine responded use of farm-raised shrimp. One did not respond.

Respondents were also asked to indicate the benefits farm-raised products provide to their operations. Nine responded to all of the listed benefits. One did not respond.

Six restaurants responded they will purchase farm-raised products for their operations while two responded no. Two did not respond.

Respondents were asked whether they used their terms aquaculture or farm-raised as a marketing tool on their menus, eight responded no and two did not respond.

Respondents were asked to compare the farm-raised product to wild caught product on a scale of 1 to 5. Four evaluated the product at a scale of 3, two at a scale of 4 and one at a scale of 2. Three did not respond.

Sushi

Years in operation
Survey respondents were asked how many years their business has been in operation. Five restaurants responded between 1 – 5 years, one responded 6 – 10 years and one restaurant responded between 11 – 15 years. One restaurant did not respond.

Location of operation
Seven responded their location is situated in a suburban setting and one restaurants indicated their location is situated in an urban setting. One restaurant did not respond.

Types of seafood purchased
Respondents were asked what types of seafood purchased for their operations. A total of seven restaurants responded both finfish and shellfish. One restaurant did not respond.

Sources of seafood
Respondents were asked to identify how they acquired their seafood from various sources. Seven responded they acquired their seafood from processors and five responded they acquired their seafood from the wholesale fish market. One did not respond. None reported acquiring their seafood directly from boats, fish farms or itinerant vendors.

Price
Respondents indicated they will purchase the required sizes for twenty-five dollars and over (≥$65.00). For the 10/15 count, one restaurant indicated their willingness to pay between forty-five and fifty ($45-50) and more than sixty dollars (≥$60), for 15/25 count four indicated willingness to pay between twenty-five and thirty-five ($25-35), forty-five and fifty dollars ($45-50) and fifty to sixty dollars ($50-60). For the 35/45 count one indicated willingness to pay between thirty-five and forty-five ($35-45). One did not respond.

Size requirement
Respondents did not respond to the size requirement for a head on/ shell on product, instead they responded to a head off/ shell off product which is currently available on the market. Restaurants indicated more than one size requirements in this category. The majority indicated they preferred a larger product (head off/shell off) to the sample delivered. Two respondents preferred a 10/15 count, six a 15/25 count and one a 35-45 count. One did not respond.

Frequency and quantity
Three responded they will purchase products weekly and four bi-weekly. The quantity required by restaurants varied. Table 11 provides a breakdown of the average quantity. One did not respond.

Table 11:Quantity of Shrimp required by Sushi Restaurants

Frequency	Average (lbs)
Weekly	140
Bi-weekly	250

Market type and market form

Five responded they would prefer a frozen product and three a fresh product. In terms of the market form, six responded head-off, four responded peeled and deveined, one responded "As is" (head-on shell-on, one responded deveined and one responded easy peel. One did not respond.

Method of preparation

Restaurants utilized various methods in the preparation of the samples. Three restaurants utilized more than one method. Six steamed, three baked, one curried and one raw. One did not respond.

Acceptance/Satisfaction/Suggestions

A higher number of respondents in this category were satisfied with the product. Four responded satisfied and three responded neutral and one very satisfied. None of the respondents were unsatisfied with the product.

Six respondents reported to like the freshness of the product the most whilst one responded the packaging. Two did not like the appearance of the product. One did not respond.
Five restaurants did not respond to the question on suggestions for improvements. Three responded partial processing, one willing to purchase right away and one responded improvement about the labelling.

Aquaculture products

Respondents were asked various questions pertaining to aquaculture products. Seven responded they already use aquaculture or farm-raised products. Seven responded use of farm-raised shrimp, two responded use of farm-raised salmon, one responded use of farm-raised oysters. One did not respond.

Respondents also was asked to indicate the benefits farm-raised products provide to their operations. Seven responded to all of the listed benefits. One did not respond.

In terms of respondents' willingness to purchase farm-raised products, six responded they will purchase farm-raised products for their operations while one responded no. One did not respond.

Respondents were asked whether they used the terms aquaculture or farm-raised as a marketing tool on their menus, eight responded no and two did not respond.

Respondents were asked to compare the farm-raised product to wild caught product on a scale of 1 to 5. One evaluated the product at a scale of 1, three evaluated the product at a scale of 3, two at a scale of 4 and one at a scale of 5. One did not respond.

Appendix 5: Profitability model: Assumptions and Results

Assumptions and Results

		2016		Discounting Rate	15%		
Investment:		MUSD		**Planning Horizon**	**10**	**years**	
Buildings		200					
Equipment	100%	362			**Total Cap**	**Equity**	**Dividend**
Other		30		**NPV of Cash Flow**	**92**	**173**	
Total	100%	**592**		**Internal Rate**	**19%**	**36%**	
Financing:							
Working Capital		10		**Capital/Equity**			
Total Financing		602		**after 10 years**			
Equity	100%	30%					
Loan Repayments	100%	10	years				
Loan Interest	100%	10%					

Operations:			**2017**	**2018**	**2019**	**2020**	**2021**	
Sales Quantity	100%		3.0	3.0	3.0	3.0	3.0	ton/year
Sales Price	100%		77.0	77.0	77.0	77.0	77.0	KTT/ton
Variable Cost	100%	16	KTT/ton					
Fixed Cost	100%	34	MTT/year					
Inventory Build-up			**22**					
Debtors	10%	of turnover						
Creditors	15%	of variable cost						
Dividend	30%	of profit						
Depreciation Buildi	4%							
Depreciation Equip	15%							
Depreciation Other	20%							
Loan Managem. Fe	2%							
Income Tax	13%							

Appendix 6: Investment and Finan

Profitability model: Investment and Finance

Year		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
Investment and Financing			1	2	3	4	5	6	7	8	9	10	
Investment:													
Buildings		200	192	184	176	168	160	152	144	136	128	120	
Equipment		362	308	253	199	145	91	36	36	36	36	36	
Other		30	24	18	12	6	0	0	0	0	0	0	
Booked Value		**592**	**524**	**455**	**387**	**319**	**251**	**188**	**180**	**172**	**164**	**156**	
Depreciation:													
Depreciation Buildings	4%		8	8	8	8	8	8	8	8	8	8	**80**
Depreciation Equipm.	15%		54.3	54.3	54.3	54.3	54.3	54.3					**325.8**
Depreciation Other	20%		6	6	6	6	6						**30**
Total Depreciation			**68.3**	**68.3**	**68.3**	**68.3**	**68.3**	**62.3**	**8**	**8**	**8**	**8**	**435.8**
Financing:		602											
Equity	30%	180.6											
Loans	70%	421.4											
Repayment	10			42.1	42.1	42.1	42.1	42.1	42.1	42.1	42.1	42.1	**379.3**
Principal		421.4	421.4	379.3	337.1	295.0	252.8	210.7	168.6	126.4	84.3	42.1	
Interest	10%		42.1	42.1	37.9	33.7	29.5	25.3	21.1	16.9	12.6	8.4	**269.7**
Loan Managem. Fees	2%	8.4											

Appendix 7: Operations

Profitability model:Operations

Year		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
Operations Statement													
Sales			3	3	3	3	3	3	3	3	3	3	
Price			77	77	77	77	77	77	77	77	77	77	
Revenue			**231**	**231**	**231**	**231**	**231**	**231**	**231**	**231**	**231**	**231**	**2,310**
Variable Cost	16		48	48	48	48	48	48	48	48	48	48	480
Fixed Cost	34		34	34	34	34	34	34	34	34	34	34	340
Diverse Taxes			0	0	0	0	0	0	0	0	0	0	0
EBITDA (Operating Surplus)			**149**	**149**	**149**	**149**	**149**	**149**	**149**	**149**	**149**	**149**	**1,490**
Depreciation			68.3	68.3	68.3	68.3	68.3	62.3	8	8	8	8	**435.8**
Operating Gain/Loss			**81**	**81**	**81**	**81**	**81**	**87**	**141**	**141**	**141**	**141**	**1054**
Financial Costs: Interest and Loan Mgmt fee		8	42	42	38	34	29	25	21	17	13	8	278
EBT (Profit before Tax)		**-8**	**39**	**39**	**43**	**47**	**51**	**61**	**120**	**124**	**128**	**133**	**776**
Loss Transfer	0	-8	0	0	0	0	0	0	0	0	0	0	
Taxable Profit		0	30	39	43	47	51	61	120	124	128	133	
Income Tax	13%	0	4	5	5	6	6	8	15	16	16	17	97
Net Profit/Loss		**-8**	**35**	**34**	**37**	**41**	**45**	**54**	**105**	**109**	**112**	**116**	**679**

Appendix 8: Cash Flow over planning horizon of ten years

Profitability model:Cash Flow

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
Cash Flow												
EBITDA (Operating Surplus)	0	149	149	149	149	149	149	149	149	149	149	1490
Debtor Changes		23.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.1
Creditor Changes		7.2	0	0	0	0	0	0	0	0	0	7.2
Inventory Changes		0	0	0	0	0	0	0	0	0	0	0
Financing - Expenditure	10											10
Cash Flow before Tax	10	133	149	149	149	149	149	149	149	149	149	**1,530**
Paid Taxes		0	4	5	5	6	6	8	15	16	16	80
Cash Flow after Tax	10	133	145	144	144	143	143	141	134	133	133	**1,404**
Financial costs (Interest and Loan Mgmt fee)	8	42	42	38	34	29	25	21	17	13	8	278
Repayment	0	0	42	42	42	42	42	42	42	42	42	379
Free (Net) Cash Flow	2	91	61	64	68	71	75	78	75	79	82	**746**
Paid Dividend 30%		0	10	10	11	12	13	16	31	33	34	171
Cash Movement	2	91	51	54	57	59	62	62	44	46	49	**575**

Appendix 9: Sensitivity analysis of equipment, production, sales price, fixed costs and variable costs for the shrimp model

Deviations	Values	Equipment	Production	Sales price	Fixed costs	Variable costs
-50%	50%	276	-310	-428	111	188
-40%	60%	243	-220	-314	111	172
-30%	70%	210	-134	-200	111	157
-20%	80%	177	-51	-94	111	142
-10%	90%	144	30	9	111	126
0%	100%	111	111	111	111	111
10%	110%	78	192	213	111	96
20%	120%	45	273	315	111	80
30%	130%	12	354	417	111	65
40%	140%	-21	435	519	111	50
50%	150%	-54	516	621	111	35