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ECONOMIC SUSTAINABILITY OF SMALL SCALE MILKFISH FARMING IN TANZANIA

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ABSTRACT

This paper assesses the economic sustainability of milkfish farming in Tanzania using a profitability model as the main assessment tool. This tool is for planning, managing and helping with decision making in investment projects. This study examines the case study of the UWASA project in Mtwara Tanzania, and assesses the feasibility of small scale milkfish farming to determine if it can be a business enterprise. Data were collected from primary and secondary sources and assumptions were made based on the author´s experience with milkfish farming. All data and assumptions were analyzed both in a production model and a profitability model. A budget for 1 ha milkfish pond farm was used to assess the profitability of small scale milkfish farming. The planning horizon was 5 years, including 1 year for construction. Net present value, internal rate of return, and payback period were determined. A sensitivity analysis was conducted on equipment cost, pond construction, production, sales price, variable and fixed cost. The findings of the analysis indicate that milkfish farming can be economically sustainable. The results show positive IRR and NPV and a payback period of two years (one year operation) with minimal risk. Small scale milkfish farming is sensitive to sales price and production.

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1 INTRODUCTION

Tanzania is a coastal state with abundant fisheries resources both marine and inland. It has a coastline of about 1,424 kilometers (Mtui, 2008) stretching from latitude 4°49'S at the border with Kenya to latitude 10°28'S with the border of Mozambique. The coast is characterized by a mixture of sand beaches, rocky shores, extensive coral reefs, dense mangrove forests and abundant biodiversity (Kyomo, 1999) and Mgaya and Chande, 2003).

Coastal communities depend largely on fishing activities for their livelihoods, income and protein. The sector plays a significant role in promoting both social and national economic growth, enhancing local food security, and providing household cash income in Tanzania.

The aquaculture sub-sector has a great potential for expansion however, due to the fact that demand for fish is increasing as a result of population growth and declining capture fisheries. Tanzania has ample land, seawater (and freshwater) and labor to immensely expand the current aquaculture production. Small scale aquaculture production can be run with a relatively low capital investment and maintenance costs and is thus an ideal new industry to develop in growing fisheries based communities.

Coastal communities in Tanzania practice different activities besides fishing; along the shore there is seaweed farming while in mangrove areas they practice milkfish farming, crab fattening and bee keeping.

Milkfish production in Tanzania is small scale, it started officially 10 years ago. Prior to that people were farming milkfish as a by catch in salt pans during salt production in mangrove areas. Milkfish has good farming potential as milkfish can be raised in different production systems, depending on the available resources. In 2007 data started to be collected on milkfish farming and since then a slow increase of production has been seen.

Despite increase of production, milkfish farming faces numerous challenges which hinder sustainability of the fish farming. Educated and experienced consultants are still few and far between. Farming milkfish for subsistence and not as business venture does not increase income and does not advance development of the industry. The dependence of farming on donor projects or government funds for milkfish farming does not always promote the individuals that have the necessary drive as the initiative comes from above and when funds end less interested farmers fail to continue on their own.

Despite previous failures to sustain it in the long term, coastal communities are interested in practicing milkfish farming. However, limited accessibility of funds and lack of information on how to run milkfish as a business are also obstacles. Money lenders or banks are not willing to give money to milkfish farmers because they do not see it as a viable business. Little information on how to do milkfish farming in a sustainable way is available thus people are afraid to take risks for this kind of business.

According to Requintina, *et al* (2006) and Tanzania coast management partnership are responsible for analyzing the economic value of milkfish farms and potentiality for economic development and policy.

The aim of this project is to assess feasibility of milkfish farming using a profitability model. This is an ideal a way of calculating information that will arm farmers with the data they need to develop their farms and could help transfer milkfish from subsistence to business.

This project will help different stakeholders, including farmers, coastal district government, mariculture investors and money lenders to use models as tools to understand how milkfish farming can become a business enterprise. The profitability model can also be used as a demonstration tool for those who want to access loans for this kind of business.

2 BIOLOGY OF MILKFISH

When farming milkfish, it is essential to understand their biology. Milkfish, scientifically known as *Chanos chanos*, are the only species in the family Chanidae in the Order Gonorynchiformes. The milkfish body is elongated, moderately compressed, smooth and streamlined. Its colour is silvery on belly and sides grading to olive-green or blue on back (Figure 1).

Figure 1. Milkfish appearance *(Bagariano, 1991)*

Adult milkfish are large migratory and mature sexually in five years. In the natural environment milkfish spawn annually or biannually during warm months of the year in fully saline waters (Bagariano, 1991). Milkfish spawn in new or full moon phases. Juveniles and adults eat a wide variety of relatively soft and small food items, from microbial mats to detritus, epiphytes and zooplankton.

Milkfish can reach a maximum size of 180 cm SL (male) and 124 cm standard length (female) in the wild. The maximum recorded weight of a milkfish was a 15 year old individual 14.0 kg (FAO, 2014). Its fisheries is highly commercial, especially in aquaculture.

Milkfish produce up to five million pelagic eggs (1.1-1.2 mm in diameter) which hatch in about 24 hours (Bardach, *et al.* 1972), larvae (3.5 mm at hatching) are pelagic and stay in the plankton for up to 2-3 weeks. In the wild, eggs are probably released in deeper oceanic waters and in the outer reef region (Bagariano, 1991). Older larvae migrate onshore and settle in coastal wetlands. The larvae eat zooplankton and can thrive and grow in water as warm as 32 °C.

Fingerlings of 10-17 mm long are used as seed stock in earthen ponds, pens and cages. Milkfish fingerlings have large black eyes (Requintina, *et al.* 2006). In the wild, fingerlings are found in mangrove areas and coastal lagoons, and even travel upriver into lakes; they go back to sea when they get too large for the nursery habitat, or when they are about to mature sexually.

3 MILKFISH PRODUCTION

While exact dates are not known, milkfish farming probably started about 4 centuries ago in Indonesia and commercial production started about a century ago. The main producers of milkfish in the world are the Philippines (289,000 tons), Indonesia (254,000 tons) and Taiwan Province of China (50,000 tons). Milkfish production in 2010 is more than 800,000 tons (Figure 2). FAO records show there is a continuous increase of production since 1950 to late 70's. In 1980's there is a suddenly high increase in production, this might be due to changes of technology where by these countries shifts from earthen ponds to cage and pen farming (Wilfredo, 2007).

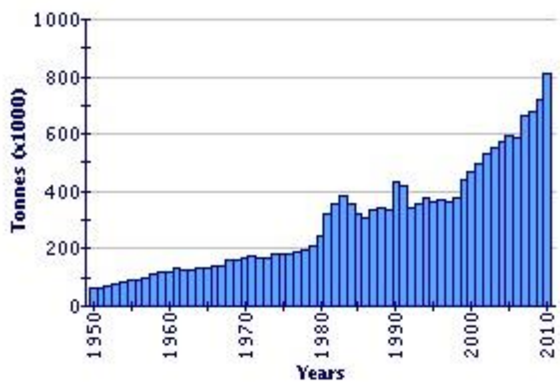

Figure 2. Global Milkfish production 1950 - 2010 (FAO, 2014)

In east Africa milkfish production is practiced in Kenya and Tanzania. An increase of milkfish production in Tanzania has been observed since 2007, as illustrated in Figure 3. In 2011/2012, production of 10 tons were recorded in Tanzania by 1,306 farmers (Ministry of Livestock and Fisheries, 2012).

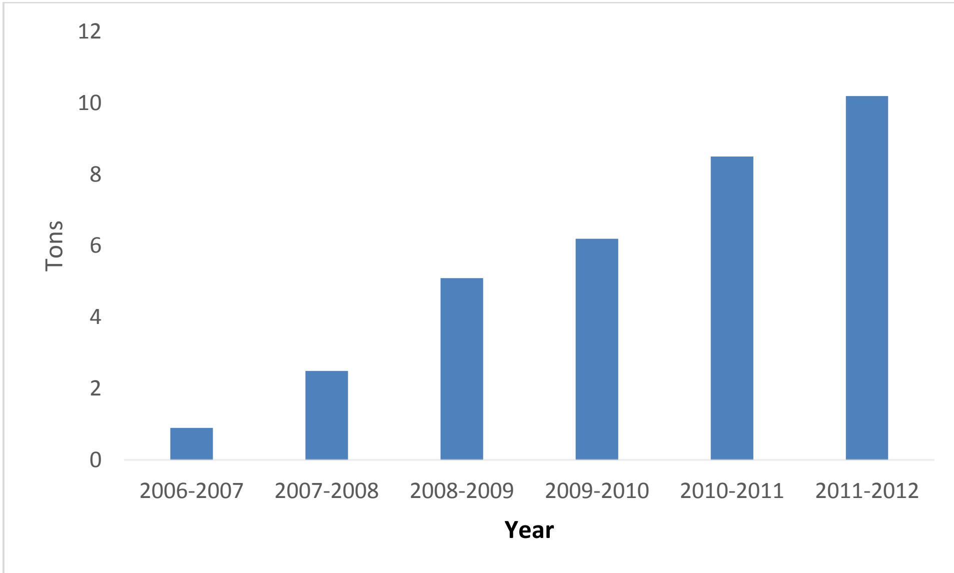

Figure 3. Milkfish production per year in Tanzania (unpublished data from government of Tanzania, ministry of livestock and fisheries)

The number of milkfish ponds in coastal districts is more than 100 (Pangani District Council, 2013). There are about 50,000 hectares suitable sites for mariculture in the country which might be used for mariculture. Despite large number of fish farm the production is still low.

In one of the projects in Mtwara Tanzania, milkfish farming is practiced within the association of a group of people from different villages. 15 groups of 121 members, where 40 of them are women from an association which is known in Swahili as Umoja wa wafugaji samaki – UWASA. This association started to collect data for their production in 2010 and one of the group recorded 0.8 tons in 2011. This shows that the potential is present, if a milkfish project gets the attention it needs.

4 MILKFISH CULTURE IN TANZANIA

In Tanzania milkfish are cultured in earthen ponds of about 1 ha. Milkfish farming activities are practiced in mangrove areas, and the government of Tanzania is still working to map all the area suitable for mariculture in mangrove areas (Bagamoyo District Council, 2013). In these areas sea water gets in twice in a month (every full and new moon). All these suitable areas can be used by small scale farmers (Pangani District Council, 2013).

Milkfish culture depends on fingerlings captured in coastal and estuarine water, fingerlings are acclimatized and reared to market size in a series of ponds. The first is a nursery pond where they grow to fingerling stage for about two months. In transitional ponds they stay for one month and lastly they are transferred to rearing ponds where they stay for about 3-4 months until they reach market size (300-400g).

Milkfish fingerlings of 10-25 mm long are abundant in coast water from March to May and September to December. This seasonal variation of milkfish fingerling availability is due to raining season. Milkfish are mostly collected during heavy rain season. The best collection times are usually made at high tides during full and new moons. The mouths of tidal creeks are particularly favorable collecting sites (Sullivan, *et al.* 2007).

After collection from the wild, milkfish fry are sorted and counted. It is important to distinguish milkfish fry from other species during stocking stages, especially tenpounders that usually prey on milkfish (Requintina, *et al.* 2006).

Milkfish ponds are prepared by adding lime and organic manure as a fertilizer for production of milkfish food. Primary sources of nutrition in cultured milkfish in the pond is a benthic mat with various components including unicellular, colonial and filamentous blue-green algae or cyanobacteria, bacteria and protozoans collectively known as 'lablab' which form after fertilization of ponds (Requintina, *et al.* 2006).

Milkfish are first grown in the nursery pond, then in transition ponds and lastly in a rearing pond as stated above. The stocking densities for all the different stages are shown in Table 1. Having different ponds ensure enough fresh 'lablab' for the different stages of fish growth which help to provide food for optimal growth conditions. In the UWASA project the stocking density (Table 1) is 2-3 fingerlings per square meter.

Table 1. Stocking density for different stages of milkfish (Requintina, *et al*. 2006)

Pond compartment	Culture period (days)	Stocking density (per m2)	Harvest (pc/kg)
Nursery pond	30 – 60	40 fry	2000
Transitional pond	30	5 fingerlings	100
Rearing pond	90 - 120	1 fish	2 - 4

For fish to attain optimal growth, water quality should be at a level that is most favourable. It is therefore necessary that water quality parameters be monitored regularly. The optimum water quality conditions for rearing milkfish are shown in Table 2.

Table 2: Optimal water quality for milkfish (Requintina, *et al.* 2006).

Parameter	Optimum
Dissolved Oxygen	3 – 5 ppm
Temperature	22 – 35°C
pH	6.8 – 8.7
Salinity	18 – 32 ppt
Turbidity	0.5 m

In Tanzania milkfish are harvested from 250 g – 500 g where by an average of 400 g is an ideal market size after about six months culture. In one experimental site in Bagamoyo district, milkfish were harvested at the weight of 500 g to 750 g in six months (Sullivan, *et al.* 2007).

After harvesting, marketing the fish is easy because fish can be sold in different market (Sullivan, *et al.* 2007) at a price of around 7000 TZS (4.3USD) per kilogram (Ministry of Livestock and Fisheries, 2012). No information shows market size milkfish sold for less than 7000 TZS/kg.

Demand for milkfish is higher in coastal communities. Farmers sell milkfish in local markets, hotels and sometimes they transport the fish to Dar es Salaam, the capital.

5 ADVANTAGE OF PRODUCING MILKFISH

High fecundity is one of the advantages of milkfish. Fingerlings in Tanzania are caught from the wild and capability of milkfish to produce high number of eggs lead to abundant supply of fry. As mentioned earlier about 5 millions of eggs may be produced by females 5-13 kg in weight (Marte, 1986).

Milkfish are hardy, euryhaline and capable of enduring a wide range of salinities, this helps them to survive even after an abrupt change of salinity. It also improves survival rate of milkfish during transport of fingerling and farming. Filling the seawater ponds for milkfish production is inexpensive compared to keeping freshwater fish in ponds, which are more difficult to fill with freshwater and to maintain the water level.

For the consumer milkfish is also seen as advantageous compared to other species of fish cultured in Tanzania. Coastal communities prefer milkfish to freshwater species. This community acceptance is what makes good market conditions for the milkfish.

6 ECONOMIC SUSTAINABILITY

It is very important to any business to be sustainable. Milkfish in Tanzania is not yet seen to last for years in operation, thus this project focuses on economic sustainability.

What is needed is the use of various strategies for employing existing resources optimally so that responsible and beneficial balance can be achieved over the longer term. Economic sustainability can be defined as using available resources efficiently so that the business continues to return profit over a number of years.

According to Foy (1990) there are more ways to look at economical sustainability however:

> Economic Sustainability requires that current economic activity which will not excessively burden future generations financially. Economists will allocate environmental assets as only part of the value of natural and manmade capital, and their preservation becomes a function of an overall financial analysis. Economic sustainability should involve analysis to minimize the social costs of meeting standards for protecting environmental assets but not for determining what those standards should be' (Foy, 1990).

An aquaculture project will be economically feasible if fish or fisheries products can be produced at a cost competitive with other animal-protein sources and can be sold at a reasonable profit. Economic considerations can be divided into investment, finance, production, and marketing (Garling, 2009).

One way of evaluating whether mariculture business is worthwhile economically is by using capital budgeting (Howard, 1993). Popular methods of capital budgeting include net present value (NPV) and internal rate of return (IRR) (Howard, 1993).

NPV is used in the analysis of the profitability of an investment or project to give indication of the present value of future earnings. It is the difference between the future cash inflows and outflows discounted to present value. If the NPV of a prospective project is positive, the project is profitable but if it is negative, the project should be abandoned. The higher the NPV value, the more profitable an investment is.

IRR on the other hand indicates the estimated rate of return that a project is expected to generate to an investment. This can be viewed as the efficiency of an investment to turn profit (Howard, 1993).

When evaluating possible investments options, both methods have their strengths and weaknesses but the NPV method is usually viewed as a more conservative estimate, and therefore safer to use than the IRR.

7 METHODOLOGY

7.1 Data collection and assumptions

This project involves the collection of secondary data on milkfish production in the coastal areas of Tanzania. The data was collected from different milkfish farms and reviewing different milkfish reports.

All production data on milkfish farming are based on the UWASA projects in Mtwara, Tanzania. Other information is from personal experience and secondary information from fisheries extension officers in Bagamoyo, and Mkuranga district.

Data was analyzed to assess if milkfish farming is economically feasible by applying profitability and production models that were developed in the project. The first year is assumed to be a construction year, followed by 4 years of operations. Planning horizon of 5 years is due to the policy in milkfish sites where it is only allowed to have a license of five years that you can renew from the district (Bagamoyo District Council, 2013). Other assumptions made are shown in Table 3.

Table 3. Assumptions used in 1 pond model of milkfish farming

	Value	Unit	Source
Currency used is TZS. 1 USD is equivalent to 1600TZS			
Pond area (nursery, transitional, rearing pond)	1	ha	UWASA
production time	6	month	(Requintina, *et al.* 2006)
Production cycle per year	2		(Requintina, *et al.* 2006)
Average pond depth	2	m	UWASA
Amount of fertilizer used (chicken manure) (50kg bag)	750	Kg/ha	(Sullivan, *et al.* 2007).
fertilizer cost	20	TZS/kg	Estimated from (Sullivan, *et al.* 2007).
Amount of lime used	1	25kg bags	
Lime cost	500	TZS/kg	Estimated from (Sullivan, *et al.* 2007).
Stocking Density	3	Fingerling/m^2	UWASA project
Initial weight of fingerling stocked	10	g	Assumed by author
Initial number of fingerling	12,0000		(Sullivan, *et al.* 2007).
Cost of fingerling	100	TZS/piece	Primary information from UWASA
Harvest weight	300-500	g	UWASA project
Milkfish price	7000	TZS/kg	UWASA. Aquaculture report
Income tax	18%		
Loan Management fees	2%		(Dar es salaam Cormercial Bank, 2014)
Depreciation of buildings	5%		Assumed by author
Depreciation of others	20%		Assumed by author
Depreciation of equipment	15%		Assumed by author
Dividend	40%		Assumed by author
Account receivable	15%		Assumed by author
Account payable	25%		Assumed by author
Loan interest without inflation	12%		(Dar es salaam Cormercial Bank, 2014)
Loan repayments	2	years	(Dar es salaam Cormercial Bank, 2014)
Loan	78%		(Dar es salaam Cormercial Bank, 2014)
Equity	22%		(Dar es salaam Cormercial Bank, 2014)
Discounting rate	15%		UWASA
Planning horizon	5	years	(Pangani District Council, 2013)

7.2 Production model

7.2.1 One pond model

Based on the assumptions in Table 3, each pond is fertilized and stocked with 12,000 milkfish fingerlings of 10 g each at a stocking density of three fingerlings per m^2.

At the end of the six month period, fish are harvested from the pond and sold. The pond is then cleaned, repaired, fertilized and restocked again. In milkfish farming there is no rest time of ponds operation because transition ponds are used to raise fish when rearing pond is cleaned and fertilized.

The production model contains initial number of fish stocked per hectare, mortality rate estimated in each month in extensive pond (Table 4), preferable size of the fingerling stocked and farm cycle. It also includes average weight for each month and biomass. The estimated maximum size of fish is 400g.

Table 4. Mortality rate of milkfish at different times

	Time (month)	Mortality rate	Source
Nursery pond	2	25%-30%	Villegas and Bombeo, (1982)
Transition pond	1	15%	Kumagai, (1980)
Rearing pond	3	10%	Lim, (1982)

Production models can be used in any kind and scale of fish farming. Production models contain a production calculation with a feed section, but in milkfish farming such section is not used because fish is not fed commercial feed since they feed on lablab generated from fertilizer as pointed out in section 4.

This production model, in first month (month 0) initially fish stocked at biomass of 120 kg, the cost used for fingerlings (1.2 MTZS), fertilizer (0.04 MTZS) and lime (0.025 MTZS) were estimated. At the end of the cycle (6 months), initial number of fish are 7047, average weight of 431 g each and biomass of 3,036 kg are seen. Cost for harvest at the end of the cycle is 0.18 MTZS (Table 5).

Table 5. One pond production model for one cycle of milkfish farming

			Initial number of fish	Initial size	Farm cycle # of months			Unit
			12,000	10 g	6			
Month	0	1	2	3	4	5	6	
Assumption scenario to mortality	15%	15%	10%	5%	3%	2%		
Number of fish at beginning of the month	12000	10200	8670	7803	7413	7190	7047	
Biomass								
Month	0	1	2	3	4	5	6	
Average weight	10	50	89	129	230	330	431	g
Biomass	120	506	774	1006	1702	2375	3036	kg
Variable cost								
Month	0	1	2	3	4	5	6	
Fingerling	1.2	0	0	0	0	0	0	MTZS
Fertilizer	0.04	0	0	0	0	0	0	MTZS
Lime	0.025	0	0	0	0	0	0	MTZS
Total	1.265	0	0	0	0	0	0	MTZS
Month	0	1	2	3	4	5	6	
Harvest labor	0	0	0	0	0	0	0.18	MTZS

7.2.2 Operating cost

Operating cost includes all cost used in operations. These include variable costs and fixed costs. Variable costs are the direct costs used to raise a kilogram of fish.

In milkfish farm total cost (number of units* estimated unit price) calculated and then used to calculate cost of each item to raise a kilogram of fish (Table 6).

Table 6. Variable cost in TZS/kg produced in a one pond production model

Items	Number unit	Unit price	Total Cost	Unit	cost	Unit
Fertilizer (50kg bag) for 1000kg	20	1,000	20,000	TZS	7	TZS/kg produced
Lime	1	25,000	25,000	TZS	8	TZS/kg produced
Labour for harvest	6	30,000	180,000	TZS	69	TZS/kg produced
Ice	400	2,000	800,000	TZS	263	TZS/kg produced
Transport	1	500,000	500,000	TZS	165	TZS/kg produced
Total		558,000	1,525,000	TZS	502	TZS/kg produced

Fixed cost includes wages, maintenance and fingerling cost. Other fixed costs may include license and consultation fee if any.

Fixed costs from milkfish farming are calculated first in one pond production in a year and then multiplied by 15 in accordance to UWASA project. In the15 ponds column, only fingerling cost and maintenance cost multiplied by 15 (Table 7). In this model fixed cost is estimated in a year not cycle.

Table 7. Fixed costs for one and 15 pond model in a year

Fixed Cost	**Number Unit**	**Unit price**	**Total cost in a year in one pond**		**Total cost of 15 ponds**	
Fingerling collection in a year	24,000	100	2,400,000	TZS	36.0	MTZS
Pond manager wage (in month)	12	50,000	600,000	TZS	0.6	MTZS
Administrations salary	1	150,000	150,000	TZS	0.2	MTZS
Consultancy	1	400,000	400,000	TZS	0.4	MTZS
Maintenance	1	400,000	400,000	TZS	6.0	MTZS
Total			3,950,000	TZS		
Contingency	10%		395,000	TZS		
Total in millions			4.3	TZS	43.2	TZS

MTZS – Million Tanzania Shillings

7.2.3 Investment cost

Milkfish farming is a business project where access to capital is one of the crucial requirements in investing in this kind of business. In a small scale milkfish farm, the amount of money invested depends on the size of production. Investment may include equipment, pond construction and working capital. All the costs involved during the start of a milkfish farm are known as 'investment costs.'

Breakdown of investment cost which were used in the model of assessing profitability of milkfish farming are shown in table 8. Further investment calculations are shown in table 13 under appendix.

Table 8. The cost needed for milkfish farm in one pond operation in a year

	Value	Unit
Pond construction	4	MTZS
Equipment	1.4	MTZS
Working capital	3	MTZS
TOTAL	8.4	MTZS

MTZS – Million Tanzania Shillings

7.2.4 N ponds Model

The information from the one pond model was used to prepare a production planning model for a multi-pond scenario. In this case, it is assumed that 15 ponds are used, as in the UWASA project. To be able to have continuous production throughout the year, stocking of fish every month is ideal but due to availability of fingerlings explained in chapter 4 above, it is only possible to stock three new ponds every three months in a year as we use in our production model. The 15 pond model can be seen in Table 10 (page 22).

In a year, all the fifteen ponds are stocked and harvest starts sixth months from the stocking month. The design of the model is such that the operator or owner can see total costs, income and operating surplus in each month and over the whole year of operation. In so doing, the farm operator or owner would be able to budget in advance what resources are needed for the production in each month.

The multi-pond scenario, or 'N pond model' can be used for one owner with more than one pond or different owners forming association for their production (as in this case study). This helps a small scale production to operate in a commercial way and not only as subsistence. The N pond model also help in economics of scale. A method to use when assessing profitability from N pond model is explained in Figure 4 below.

7.3 Profitability model

A profitability model is a model used to assess the feasibility of an investment. In this project a profitability model is used to assess the investment in milkfish farming.

A profitability model was developed based on the production model and estimation of milkfish farming costs. The profitability model has the following main components: estimation, summary (assumptions and results), investment and finance, operations statement, cash flow, balance sheet, profitability measurements and sensitivity analysis. Estimation and calculations of profitability model from construction year for 15 ponds are shown in table 11-17 in the appendix.

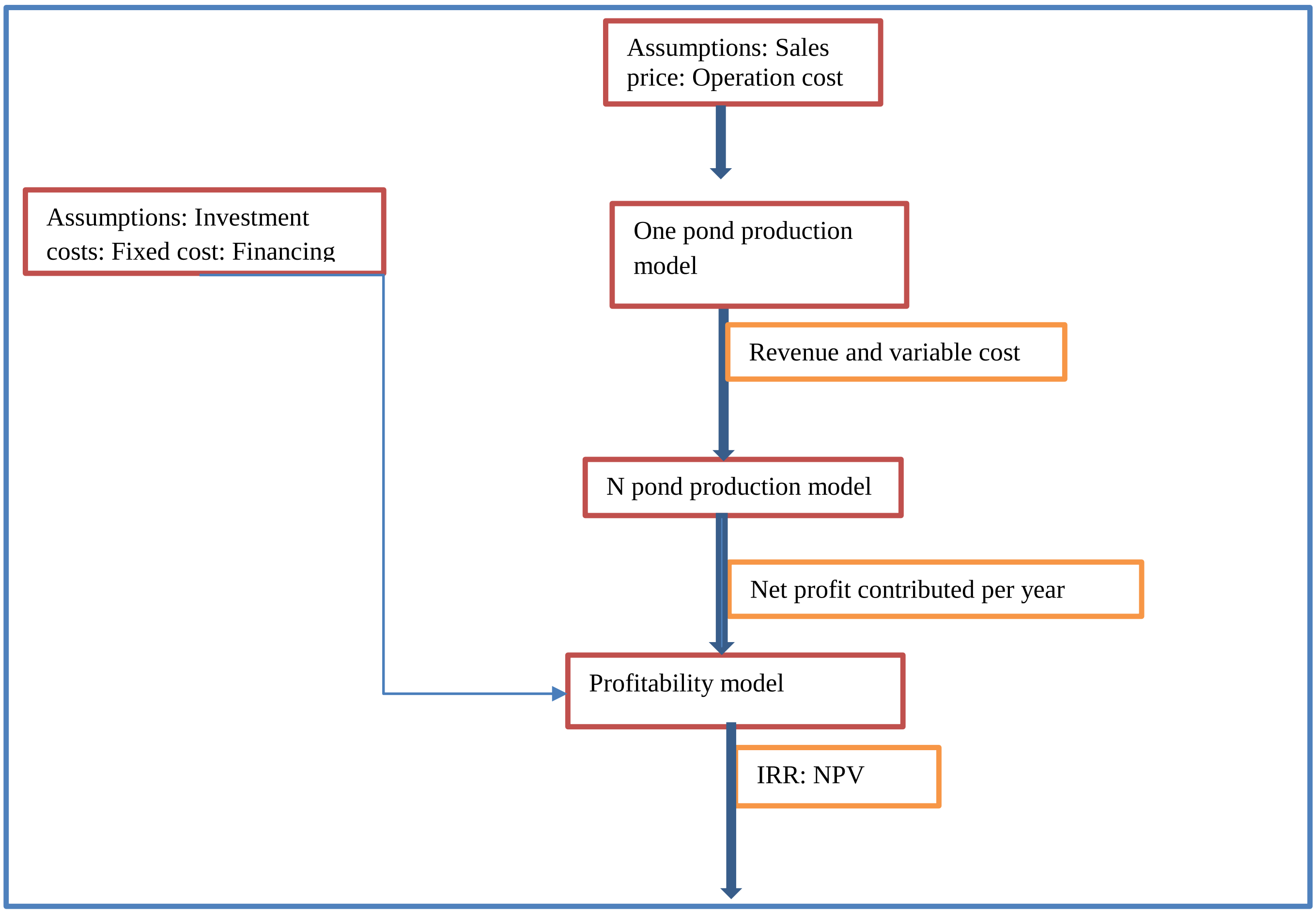

Figure 4. An overview of models applied and the components of the profitability methodology

8 RESULTS

8.1 Production from one pond

According to production model at the end of six months 7,047 fish are harvested from each pond. This is equivalent to 3 tons of biomass harvested and sold for 7000 TZS per kg for a total amount of 21 MTZS.

8.2 Cash flow

In any business, in and out movement of money is very important. In 15 pond milkfish farming a cash flow for five years was calculated as seen in Figure 5. For the first two years (2014-2015) there is a negative cash flow, while the remaining three years there is a positive cash flow.

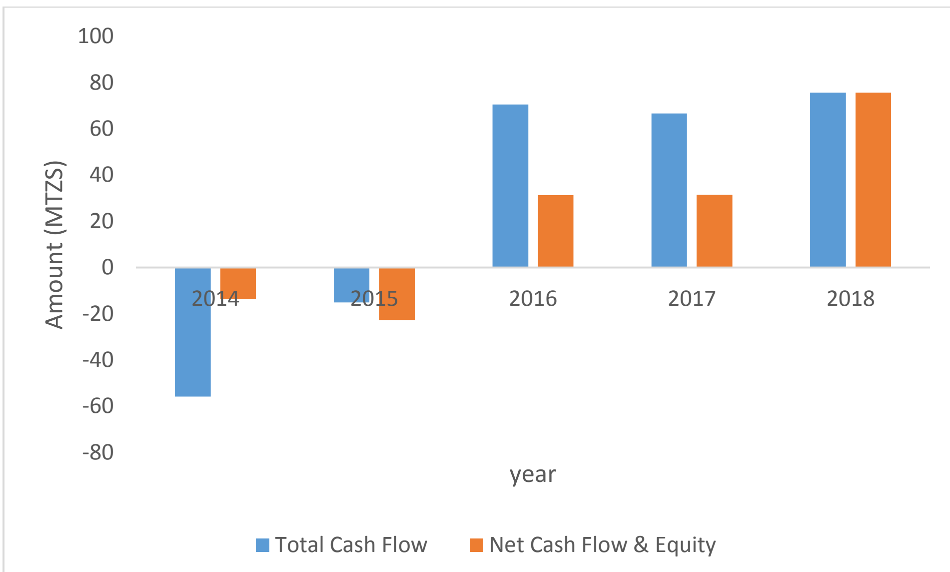

Figure 5. Cash flow for 15 ponds milkfish farming

8.3 Risk assessment

Risk assessment offers additional understanding of the threats to economic viability of the milkfish farming operation.

Payback period is used to indicate risk of the aquaculture venture. The fewer number of years of payback period the less the risky the business. In 15 ponds milkfish farming there is negative accumulated NPV for two years after starting operation. From the third year, there is a positive accumulated NPV, in this case 15% is minimum attractive rate of return (MARR) were used (Figure 6).

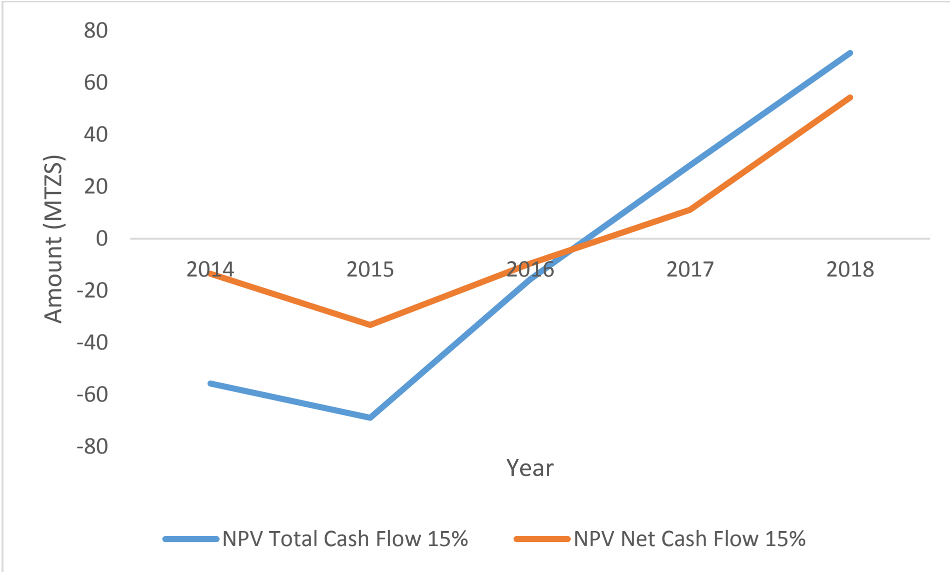

Figure 6. Accumulated Net Present Value for 15 ponds milkfish farming

8.3.1 Sensitivity analysis

The impact analysis were assessed for the milkfish farms using different variables including equipment, production, sales price, variable cost and fixed cost. The result shows that milkfish farming is most sensitive to production and sales price, (Figure 7). Any significant decrease in these two variables might destroy the economic viability of the milkfish farm.

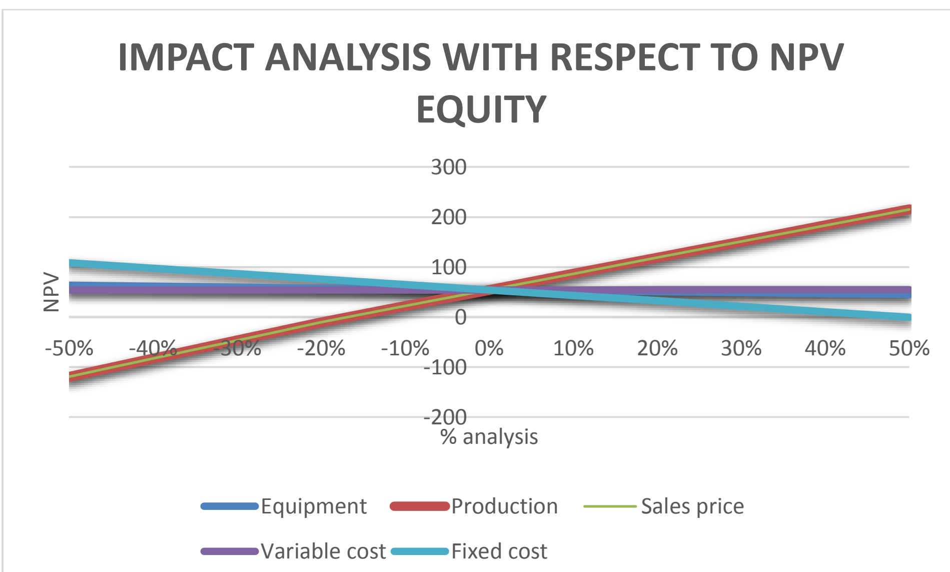

Figure 7. Impact analysis of different variable in milkfish farming

A decrease of the sales price or production of 15% is acceptable, less than that the project will operate at a loss.

8.3.2 Scenario summary

Here different scenarios of the project are shown. Four parameters, including cost of equipment, production, sales price and cost of construction were used for these scenarios. As seen in table 9, if at the same time the value of the production is decreased by 10% and the sales price by 20%, as well as increasing the cost of equipment and construction by 10% the project is no longer profitable because it gives negative IRR and NPV.

Table 9. Different scenarios on parameter in milkfish production

Scenario Summary					
		Current Values:	Pessimistic	Very pessimistic	Optimistic
Changing Cells:					
	Equipment	100%	110%	110%	90%
	Production	100%	100%	90%	110%
	Sales Price	100%	85%	80%	110%
	Construction	100%	110%	110%	90%
Result Cells:					
	NPV	54	1	-45	127
	IRR	69%	16%	-22%	157%

8.4 Production of more than one pond

For the UWASA project to be able to have a sustainable production, a 15 ponds production model was developed where three ponds will be stocked at once every three months as explained in section 6.2.4.

The result for the first year shown in Table 10 below, where in the first month there is total cost of fingerling, fertilizer and lime (1.3 MTZS) while in 6th month (end of the cycle) there is an approximate cost of harvest (0.2 MTZS) and revenue (5.3 MTZS).

The cost for 1st month is the same as 7th month because both are first month of the cycle while cost for 6th and 12th month are the same because both are the last months of the cycle. At the end there is total cost used, total income and total operation surplus in each month. Net income at the end of the year is shown. Other three years are shown in tables 18 – 20 in the appendix.

Table 10. A 15 ponds model of milkfish production in Million Tanzania Shillings
TOS – Total operation surplus

													Year 1
Months		1	2	3	4	5	6	7	8	9	10	11	12
ponds 1	Cost	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2
	Revenue						5.3						5.3
	Operating	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1
Pond 2	Cost	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2
	Revenue	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3
	Operating	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1
Pond 3	Cost	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2
	Revenue	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3
	Operating	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1
Pond 4	Cost			1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue			0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating			-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 5	Cost			1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue			0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating			-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 6	Cost			1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue			0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating			-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 7	Cost						1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Revenue						0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Operating						-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Pond 8	Cost						1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Revenue						0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Operating						-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Pond 9	Cost						1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Revenue						0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Operating						-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Pond 10	Cost									1.2	0.0	0.0	0.0
	Revenue									0.0	0.0	0.0	0.0
	Operating									-1.2	0.0	0.0	0.0
Pond 11	Cost									1.2	0.0	0.0	0.0
	Revenue									0.0	0.0	0.0	0.0
	Operating									-1.2	0.0	0.0	0.0
Pond 12	Cost									1.2	0.0	0.0	0.0
	Revenue									0.0	0.0	0.0	0.0
	Operating									-1.2	0.0	0.0	0.0
Pond 13	Cost												1.2
	Income												0.0
	Revenue												-1.2
Pond 14	Cost												1.2
	Income												0.0
	Operating												-1.2
Pond 15	Cost												1.2
	Revenue												0.0
	Operating												-1.2
Total cost		3.7	0.0	3.7	0.0	0.0	4.3	3.7	0.5	7.5	0.0	0.7	9.3
Total Income		0.0	0.0	0.0	0.0	0.0	15.8	0.0	15.8	0.0	0.0	15.8	15.8
TOS		-3.7	0.0	-3.7	0.0	0.0	11.5	-3.7	15.2	-7.5	0.0	15.2	7.7
Net income													31.0

9 DISCUSSION

In this project, a tool to aid in decision making was developed and used to assess the profitability of milkfish farming in Mtwara, Tanzania. This tool can be used in any aquaculture farm of small or large scale. It can also be used to plan for a long time aquaculture venture.

In order to assess the profitability for N ponds, the use of a one pond production model is necessary as seen in Figure 4. Assumptions on sales price and operation cost are used in the production model. Revenue and variable cost are then transferred to the N pond production model. Net profit contributed per year in a N pond model are used with investment cost, fixed cost and financing in the profitability model to calculate IRR and NPV which is used to assess whether mariculture business is economically feasible (Howard, 1993).

During this study it was estimated that a farmer may need for each pond to have a variable cost of 1.5 Million TZS as shown in table 6 and fixed cost of 4.3 Million TZS as shown in table 7 for the farm to be economically viable. In order for a farmer to construct a 1 ha milkfish pond he/she needs to have initial capital of 8.4 Million TZS. For small scale milkfish farm this might be large amount of money, thus it is advised to take loans with 22% owners' equity as assumed in table 5.

Due to the high investment cost, it might be difficult to for small scale farmers to get access to capital of such an amount. Thus this model can be used to demonstrate the profitability when accessing loan.

Annual production from this study for a 1 ha pond during the first year of operation was estimated to be 1.5 tons as ideal for small scale milkfish farming and not 6 tons in a year (3 tons per cycle) as shown in production model (Table 5). This production (1.5 tons) is still high compared to 0.8 tons in a year reported in the UWASA project where they farm one cycle in a year. Different studies report production of milkfish up to about 8 tones per cycle in a cage farming (Wilfredo, 2007). This model needs to be tested in real situation to see actual results.

Net income in a year is very promising in the UWASA project from the 15 ponds model (Appendix 8a-8c) thus it is better for groups in a project to stock in an interval and maintain their market throughout the year. This also helps them to get high income in a year. This model did not look at economics of scale which is the case in farming milkfish in 15 ponds. Economics of scale in investment and fixed cost might also increase the net income in a year.

To assess if milkfish farming is feasible using a profitability model, indicators of investment return such as payback period, NPV and IRR were determined as seen in the result section. Positive NPV implies that milkfish farming is feasible. The IRR is more than 50% which means that milkfish farming is very profitable. The payback period is in second year (Figure 5) of 5 years of planning horizon. This means that this venture needs two years to recover the original investment. A positive cash flow from the third year means net income is higher than the amount needed to cover expenses.

Milkfish production is sensitive to production and sales price. Reduction of sales price by 15% might make the venture infeasible. With an increase in production, there is a high supply of milkfish which might cause the price to go down, thus it is advisable for farmers to add value to their fish and increase their market. In this model calculation of transport and ice are included.

Small scale milkfish farming is found to be profitable which is very important for small scale farmers. Despite the fact that we use small scale to assess the profitability of milkfish farming, it is advisable to look at large or commercial scale in the future. This means shifting from earthen ponds to cage culture for milkfish farming. In all leading countries in milkfish production, cage farming is one of technological change which leads them to increase production of milkfish.

30% of the UWASA project members are women. It is very important for the UWASA project to sustain for a long time because it supports gender mainstreaming which provides women to resume their position in a society and recognize an opportunity to generate wealth. Sustainability of the UWASA project will help poverty alleviation and food and nutrition security.

As pointed out, milkfish culture in Tanzania depends on the availability of fingerlings in the wild. This is a problem to look at, if milkfish will take off as a business, number of fingerlings stocked will be high and in the future the wild will probably fail to provide such a big number of fingerlings throughout the year. More research needs to be done on milkfish fry and fingerling distribution and seasonality in Tanzania, and the establishment of a hatchery for broodstock is very important for fingerling production if the milkfish production increases considerably.

There is a need to involve district officers in data collection, record keeping and monitoring environmental and social impacts. This is because in all coastal districts there is an Integrated Coastal Management (ICM) team which oversees all coastal development projects. It will also help farmers to get assistance from the government.

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APPENDIX: MODELS

Table 11: Profitability model; Estimations

Estimations						
Investment cost						
	Construction					
				Unit price	**Amount**	Unit
		Site Preparation (1 ha)	1	500,000	500,000	TZS
		Earth work (1 ha)	1	1,000,000	1,000,000	TZS
		Main gate labor	1	200,000	200,000	TZS
		Secondary gate labor (6 small gates)	6	100,000	600,000	TZS
		Total			**2.3**	MTZS
	Equipment					
		wire gauge (m)	3	5,500	16,500	TZS
		Net for harvest	1	400,000	400,000	TZS
		Machetes	5	13,000	65,000	TZS
		Cement	4	17,000	68,000	TZS
		Nail	2	3000	6,000	TZS
		Shovels	20	10,000	200,000	TZS
		Wood	5	15,000	75,000	TZS
		Crates	10	25,000	250,000	TZS
		Pebble	1	50,000	50,000	TZS
		Stones	1	100,000	100,000	TZS
		Sand	1	60,000	60,000	TZS
		Total			1,290,500	TZS
		Contingency	10%		129,050	TZS
		Equipment total			**1.4**	MTZS
Operating cost						
	variable cost					
				Unit price	Total Cost	
		Fertilizer (50kg bag) for 1000kg	20	1000	20,000	TZS
		Lime	1	25,000	25,000	TZS
		Labor for harvest	6	30,000	180,000	TZS
		Ice	400	2000	800,000	TZS
		Transport	1	500,000	500,000	TZS
		Total		558000	1,525,000	
	Fixed cost			**Unit price**	**Total in a year**	
		Fingerling	24,000	100	2,400,000	TZS
		Pond managing labor (in month)	12	50,000	600,000	TZS
		Administrations	1	150,000	150,000	TZS
		Consultancy	1	400,000	400,000	TZS
		Maintenance	1	400,000	400,000	TZS
		Total			3,950,000	TZS
		Contingency	10%		395,000	TZS
		Total			**4.3**	MTZS

Table 12: Profitability model: Assumption and results

Assumptions and Results								
		2014		Discounting Rate		15%		
Investment:		MTZS		Planning Horizon		5	years	
Pond Construction	100%	34.5						
Buildings		-						
Equipment	100%	21.3				Total Cap.	Equity	
Other		0.0		NPV of Cash Flow		73	56	
Total		55.8		Internal Rate		51%	70%	
Financing:								
Working Capital		25.0						
Total Financing		80.8						
Equity	100%	22%						
Loan Repayments	100%	2	years	Minimum Cash Account		1.1		
Loan Interest (without inflation)	100%	12%						
Operations:			**2015**	**2016**	**2017**	**2018**	**2019**	
Production	100%		1.5	1.6	1.7	1.8	2.0	ton/year
Sales Price	100%		7.0	7.0	8.0	8.5	8.5	MTZS/ton
Variable Cost	100%	0.5	KTZS/kg					
Fixed Cost	100%	43.2	MTZS/year					
Inventory Build-up			0					
Debtors(Account receive)	25%	of turnover						
Creditors (Account payable)	15%	of variable cost						
Dividend	40%	of profit						
Depreciation Buildings	10%							
Depreciation Equipment.	15%	over 5yrs						
Depreciation Other	20%							
Loan Management. Fees	2%							
Income Tax	18%							
Pond depreciation	20%							

MTZS – Million Tanzania shillings; KTZS – Thousands Tanzania shillings

Table13: Profitability model; Investment and financing in million Tanzania shillings

		2014	2015	2016	2017	2018
Investment and Financing			1	2	3	4
Investment:						
Buildings		0.00	0.00	0.00	0.00	0.00
Pond construction		34.50	27.60	20.70	13.80	6.90
Equipment		21.29	18.10	14.91	11.71	8.52
Other		0.00	0.00	0.00	0.00	0.00
Booked Value		**55.79**	**45.70**	**35.61**	**25.51**	**15.42**
Depreciation:						
Depreciation Buildings	10%	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Depreciation pond	20%	**0.00**	**6.90**	**6.90**	**6.90**	**6.90**
Depreciation Equipment.	15%	0.00	3.19	3.19	3.19	3.19
Depreciation Other	20%		**0.00**	**0.00**	**0.00**	**0.00**
Total Depreciation		0.00	10.09	10.09	10.09	10.09
Financing:		**80.79**				
Equity	22%	**17.77**				
Loans	78%	**63.02**				
Repayment	2			31.51	31.51	
Principal		63.02	63.02	31.51	0.00	0.00
Interest	12%		7.56	7.56	3.78	0.00
Loan Management Fees	2%	1.26	0.00	0.00	0.00	

Table14: Profitability model; Operation statement

		2014	2015	2016	2017	2018
Operations Statement						

Sales			1.5	1.6	1.7	1.8
Price			7	8	8.5	8.5
Revenue			**11**	**13**	**14**	**15**
Variable Cost	0.5		0.8	0.8	0.9	0.9
Net profit contribution			31.0	114.8	114.8	129.7
Fixed Cost	43.2		43.2	43.2	43.2	43.2
Diverse Taxes						
Operating Surplus (EMITDA)			**-12**	**72**	**72**	**87**
Inventory Movement						
Depreciation			10	10	10	10
Operating Gain/Loss			**-22**	**62**	**62**	**76**
Financial cost		1.3	7.6	7.6	3.8	0.0
Profit before Tax		-1.26	-29.85	53.94	57.72	76.45
Loss Transfer	0	-1.26	-31.11	0.00	0.00	0.00
Taxable Profit		0.00	0.00	22.84	57.72	76.45
Income Tax	18%	0.00	0.00	4.11	10.39	13.76
Profit after Tax		-1.26	-30	50	47	63
Dividend	**40%**	0	0.00	20	19	25
Net Profit/Loss		**-1.26**	**-29.85**	**29.90**	**28.40**	**37.61**

Table15: Profitability model; Cash flow

	2014	**2015**	**2016**	**2017**	**2018**
Cash Flow					
Operating Surplus(EBITDA)		-12.19	71.60	71.60	86.54
Debtor Changes (Account receive)		2.63	0.58	0.41	0.21
Creditor Changes (Account Payable)		0.11	0.01	0.01	0.01
Inventory Changes		0.00	0.00	0.00	0.00
Cash Flow before Tax		**-14.70**	**71.03**	**71.20**	**86.34**
Paid Taxes		0.00	0.00	4.11	10.39
Cash Flow after Tax		**-14.70**	**71.03**	**67.08**	**75.94**
Financial cost	1.26	7.56	7.56	3.78	0.00
Repayment	0.00	0.00	31.51	31.51	0.00
Free/Net Cash Flow	**-1.26**	**-22.26**	**31.96**	**31.79**	**75.94**

Paid Dividend	0.00	0.00	0.00	19.93	18.93
Financing - Expenditure Working capital	25.00				
Cash Movement	**23.74**	**-22.26**	**31.96**	**11.86**	**57.01**

Table16: Profitability model; Cash flow

		2014	**2015**	**2016**	**2017**	**2018**
Balance Sheet						
Assets						
Cash Account	0	23.74	1.48	33.44	45.30	102.31
Debtors (account received)	25%	0.00	2.63	3.20	3.61	3.83
Inventory	0	0.00	0.00	0.00	0.00	0.00
Current Assets		**23.74**	**4.10**	**36.64**	**48.91**	**106.13**
Fixed Assets		55.79	45.70	35.61	25.51	15.42
Total Assets		**79.53**	**49.80**	**72.24**	**74.42**	**121.55**
Debts						
Dividend Payable		0.00	0.00	19.93	18.93	25.07
Taxes Payable		0.00	0.00	4.11	10.39	13.76
Creditors (Account payable)	15%	0.00	0.11	0.12	0.13	0.14
Next Year Repayment		0.00	31.51	31.51	0.00	0.00
Current Liabilities (short term debts)		**0.00**	**31.62**	**55.67**	**29.45**	**38.97**
Long Term Loans		63.02	31.51	0.00	0.00	
Total Debt		**63.02**	**63.13**	**55.67**	**29.45**	**38.97**
Equity		17.77	17.77	17.77	17.77	17.77
Profit & Loss Balance		-1.26	-31.11	-1.21	27.19	64.81
Total Capital		**16.51**	**-13.33**	**16.57**	**44.97**	**82.58**
Debts and Capital		**79.53**	**49.80**	**72.24**	**74.42**	**121.55**
Error check		0.00	0.00	0.00	0.00	0.00

Table17: Profitability model; Profitability measurement

		2014	2015	2016	2017	2018
Profitability Measurements						
NPV and IRR of Total Cash Flow						
Cash Flow after Taxes		0	-15	71	67	76
Investment		-56				
Total Cash Flow		**-56**	**-15**	**71**	**67**	**76**
NPV Total Cash Flow	15%	**-56**	**-69**	**-15**	**29**	**73**
IRR Total Cash Flow				**0%**	**35%**	**51%**
NPV and IRR of Net Cash Flow						
Free/Net Cash Flow		-1	-22	32	32	76
Equity part of Investment		-12.3				
Net Cash Flow & Equity		**-14**	**-22**	**32**	**32**	**76**
NPV Net Cash Flow	15%	**-14**	**-33**	**-9**	**12**	**56**
IRR Net Cash Flow					36%	70%
Financial Ratios						
Liquid Current Ratio			0.1	0.7	1.7	2.7
Debt Service Coverage			-1.9	1.8		
Internal value of share (Total Capital/Equity)				1.0	1.0	1.0

Table 18: A 15 ponds model; year 2 of operation in million Tanzania shillings

													year 2
Months		1	2	3	4	5	6	7	8	9	10	11	12
ponds 1	Cost	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2
	Revenue	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3
	Operating	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1
Pond 2	Cost	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2
	Revenue	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3
	Operating	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1
Pond 3	Cost	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2

	Revenue	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3
	Operating	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1
Pond 4	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 5	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 6	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 7	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Revenue	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Pond 8	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Revenue	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Pond 9	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Revenue	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Pond 10	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 11	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 12	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 13	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Income	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Revenue	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Pond 14	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Income	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Pond 15	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Revenue	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Total cost		3.7	1.1	7.5	0.0	1.3	9.3	3.7	1.1	7.5	0.0	1.3	9.3
Total Income		0.0	31.5	0.0	0.0	31.5	15.8	0.0	31.5	0.0	0.0	31.5	15.8
TOS		-3.7	30.4	-7.5	0.0	30.4	7.7	-3.7	30.4	-7.5	0.0	30.4	7.7
Net income													114.8

TOS – Total operating surplus

Table 19: A 15 ponds model; year 3 of operation in million Tanzania shillings

													Year 3
Months		1	2	3	4	5	6	7	8	9	10	11	12
ponds 1	Cost	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2
	Revenue	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3
	Operating	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1
Pond 2	Cost	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2
	Revenue	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3
	Operating	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1
Pond 3	Cost	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2

	Revenue	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3
	Operating	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1
Pond 4	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 5	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 6	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 7	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Revenue	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Pond 8	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Revenue	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Pond 9	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Revenue	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Pond 10	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 11	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 12	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0
Pond 13	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Income	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Revenue	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Pond 14	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Income	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Pond 15	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	1.2
	Revenue	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2
Total cost		3.7	1.1	7.5	0.0	1.3	9.3	3.7	1.1	7.5	0.0	1.3	9.3
Total Income		0.0	31.5	0.0	0.0	31.5	15.8	0.0	31.5	0.0	0.0	31.5	15.8
TOS		-3.7	30.4	-7.5	0.0	30.4	7.7	-3.7	30.4	-7.5	0.0	30.4	7.7
Net income													114.8

TOS –Total operating surplus

Table 20: A 15 ponds model; year 4 of operation in Million Tanzania shillings.

													Year 4
Months		1	2	3	4	5	6	7	8	9	10	11	12
ponds 1	Cost	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2
	Revenue	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3
	Operating	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1
Pond 2	Cost	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2
	Revenue	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3
	Operating	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1
Pond 3	Cost	1.2	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2

	Revenue	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3
	Operating	-1.2	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1
Pond 4	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2				
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3				
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1				
Pond 5	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2				
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3				
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1				
Pond 6	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2				
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3				
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1				
Pond 7	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	
	Revenue	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	
Pond 8	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	
	Revenue	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	
Pond 9	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	
	Revenue	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	
Pond 10	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2				
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3				
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1				
Pond 11	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2				
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3				
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1				
Pond 12	Cost	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2				
	Revenue	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3				
	Operating	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1				
Pond 13	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	
	Income	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	
	Revenue	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	
Pond 14	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	
	Income	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	
Pond 15	Cost	0.0	0.0	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.2	
	Revenue	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	
	Operating	0.0	0.0	0.0	0.0	5.1	-1.2	0.0	0.0	0.0	0.0	5.1	
Total cost		3.7	1.1	7.5	0.0	1.3	9.3	3.7	1.1	0.0	0.0	1.3	0.5
Total Income		0.0	31.5	0.0	0.0	31.5	15.8	0.0	31.5	0.0	0.0	31.5	15.8
TOS		-3.7	30.4	-7.5	0.0	30.4	7.7	-3.7	30.4	0.0	0.0	30.4	15.2
Net income													129.7

TOS – Total operating surplus