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A COMPARATIVE ECONOMIC EVALUATION OF FARMING OF THREE IMPORTANT AQUACULTURE SPECIES IN KENYA

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ABSTRACT

Information on the economic viability of aquaculture is crucial for investors when assessing the feasibility of an aquaculture investment. Unfortunately, such information has been scarce in Kenya. This paper evaluates the viability of commercial culture of three aquaculture species in Kenya under four culture practices. These are: Nile tilapia (*Oreochromis niloticus*) and African catfish *(Clarias gariepinus)*, mainly produced using mono- or polyculture under semi intensive systems; and rainbow trout *(Oncorhynchus mykiss)* produced in intensive raceways and tank systems and semi intensive production of catfish juveniles for bait in the Nile perch fisheries of Lake Victoria. Assumptions for this evaluation were based on data from aquaculture research extension information from Kenya. Other information came from the author's experience in the aquaculture extension service and as a trainer in extension service delivery. The evaluation showed all culture practices to be economically viable although at varying degrees. Culture of baitfish showed the highest viability and profitability of the four evaluated culture practices. This was attributed to its higher turnover rate compared to the others. However, an investor considering baitfish production should consider its diminishing market resulting from declining Nile perch production from Lake Victoria and the limited production zone restricted to the lake region. Monoculture of *Oreochromis niloticus* showed lower viability compared to the others. However, sensitivity analysis showed that this could be improved by enhancing productivity per unit value of input by using better fish breeds, feed with higher conversion ratios and efficient production management practices. Trout production, despite indicating best values for financial ratios, is limited by diminishing production zones and lack of appropriate feed. The success of aquaculture in Kenya will not only depend on the use of higher yielding species and efficient aquaculture production technologies, but also on the confidence of investors. For this reason, the Department of Fisheries of Kenya (DoF) needs to have appropriate information available to investors in their process of making economic decisions on aquaculture investments.

Key words: Kenya, comparative economic evaluation, baitfish, rainbow trout, polyculture, monoculture

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1 INTRODUCTION

1.1 Background

Aquaculture is playing an increasingly important role in world fish production. According to a FAO estimation, an additional 37 million tons of fish per year will be needed by 2030 to maintain current levels of fish consumption for an expanded world population. By 2030, the addition of 2 billion more people to the world population will mean that aquaculture will need to produce nearly double that, 85 million tons of fish per year, just to maintain current per capita consumption levels (FAO 2007). For the producers to increase their production, they will not only need to practice responsible aquaculture, but will need to make a profit to maintain sustainable operations.

In Kenya, resources have been put in place to promote aquaculture development through various aquaculture projects over the past few decades. The promotion started in the early 1920s as a means of supplementing protein sources in rural areas. This was a non-commercial approach and it was promoted only as a family subsistence activity (Gitonga *et al.* 2004). It has now been established that this approach does not have sufficient incentives for fish farmers to commercialise their activities (Achieng 1994). For this reason among others, aquaculture as an economic enterprise in Kenya has remained in its infancy since inception. Presently, there are just a handful of succeeding entrepreneurs. The majority of aquaculture activities involves the production of various species of tilapia (mainly *Oreochromis niloticus*) and the African catfish (*Clarias gariepinus*) under semi intensive systems using earthen ponds. There are, however, a few investors producing rainbow trout *(Oncorynchus mykiss)* under intensive systems using raceways and tanks. The tilapine species constitute about 90% of aquaculture production in Kenya. Polyculture of the tilapines with the African catfish is sometimes done to control the prolific breeding of the former under mixed sex culture systems. The production of the tilapines and the African catfish is characterised by low pond productivity mainly due to the use of low pond management practices (Mbugua 2002). The result has been the stagnation of national aquaculture production over the past few decades.

Because of the poor regard of aquaculture as an economic activity, it was difficult to promote its commercialisation, as investors were not convinced that aquaculture could be a profitable enterprise (Gitonga *et al.* 2004).

There was therefore a need to change this perception for any meaningful development in aquaculture to be realised. This could only be done, among other things, by promoting aquaculture as a commercial enterprise in which investors see potential to make profits.

In order to attain this goal, a paradigm shift was necessary. In the later part of the 1990s, the extension approach to fish farming changed, with the government promoting aquaculture as a business as opposed to subsistence farming (Gitonga *et al.* 2004). For this approach to take effect, it was necessary for aquaculture to be treated and operated as a personal enterprise with the sole aim of making economic gains to the investors.

Aquaculture investors and their financiers need to make critical decisions on the economic viability of the intended investment. On the other hand, the extension service providers require to not only make decisions on the biological feasibility of the projects, but also on their economic success. This is especially so where investors need to make comparative economic evaluations for the investment options they have.

1.2 Aquaculture in Kenya

Commercial aquaculture in Kenya involves mainly production of tilapines, African catfish, and rainbow trout. The tilapine and catfish production is mainly done as mono- or polyculture of the two under semi intensive systems while the rainbow trout production is done in intensive raceways and tank systems (Mbugua 2002). While all the species are produced for the food fish market, there has been increasing demand for baitfish for the Nile perch capture of Lake Victoria. Several entrepreneurs have started producing catfish juveniles for this market.

Aquaculture production in Kenya has shown minimal growth since the early 1920s when it started. Production has for example risen from below 200 metric tons per year during the 1950s to an average of 1,000 metric tons per year in the 2000s. This gives an average growth of less than 20 metric tons per year. It is important to note here that information on aquaculture development in Kenya is very scanty and sometimes even conflicting. This is clear from what the Department of Fisheries (DoF) of Kenya and FAO report as aquaculture production figures for Kenya as shown in Figure 1. The Department of Fisheries indicates scanty or no information at all before the late 1970s while FAO reported aquaculture production going up to 400 metric tons during the same period.

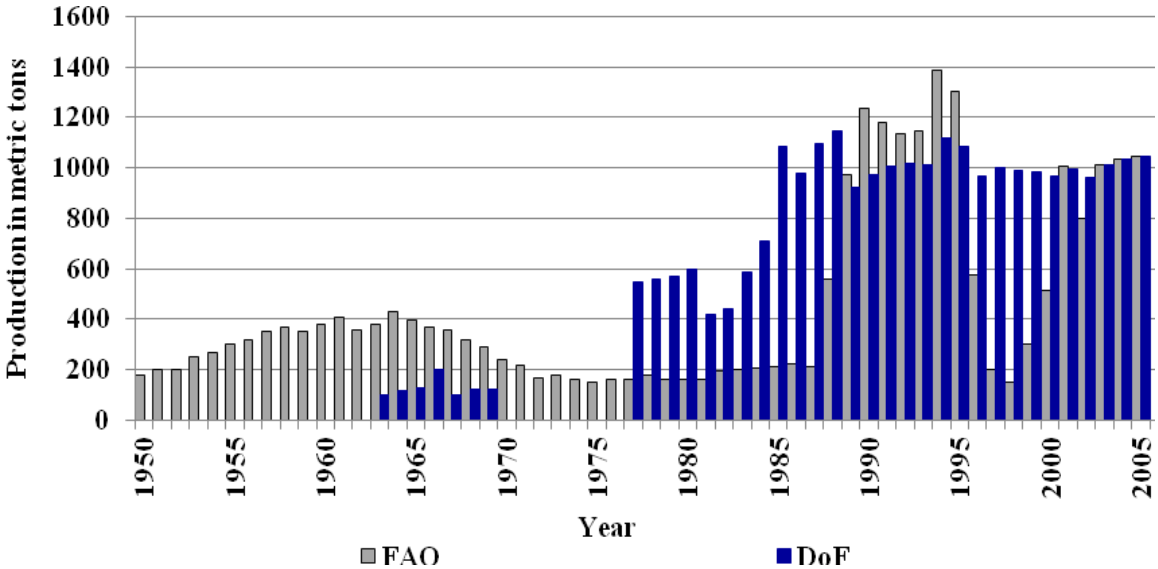

Figure 1: Aquaculture growth trends in Kenya from to two sources showing different growth patterns over the same period of time (FAO 2007 and DoF 2006)

While figures from FAO indicate an aquaculture production slightly above 200 metric tons per year before the 1990s, the Department of Fisheries of Kenya indicates an increase in production from about 550 metric tons during the mid 1980s to an average of about 1,000 metric tons per year from the early 1990s onwards. The difference could be attributed to poor information flow between the DoF, the source of

information and FAO. Inadequate information, and sometimes a complete lack of it, has resulted from poor data collection by the Department of Fisheries and poor record keeping by aquaculture producers. This has hampered aquaculture development strategies in Kenya and has affected both the Department of Fisheries in matters of aquaculture policy development and the investors when making important decisions (Gitonga *et al.* 2004).

Despite a lack of appropriate information, the Department of Fisheries has continued to promote aquaculture development through various aquaculture projects over the past few decades. This has been done, among other strategies, through training of the Departmental extension service officers in aquaculture technologies (Gitonga *et al.* 2004). The extension service has unfortunately focused more on the biological aspects of aquaculture production and less on the economic viability.

Biological processes involved in fish growth are crucial in aquaculture production. They also influence significantly the economic aspects of aquaculture production. However, aquaculture production involves more than the biological processes of fish growth. It also includes paying critical attention to the financial aspects of the production. Efficient financial management of aquaculture can make the difference between profits and losses (Carole and Ivano 2005). However, despite the importance of economic viability of investments, little attention has been paid to this during aquaculture promotion activities (Pillay and Kutty 2005). Evaluation of feasibility of culture practices can make a huge difference between enormous losses and attractive gains. Even during production, aquaculture investors need to assess the implication of allocating resources in a certain way before they do it (Curtis and Howard 1993). Aquaculture entrepreneurs need to make investment decisions and evaluate their operating culture practices.

Most aquaculture investors in Kenya lack appropriate information to make informed investment decisions. This is attributed to inadequate research information on aquaculture economics in Kenya (Omondi *et al.* 2001). They have, therefore, invested in aquaculture with unrealistic expectations. This has led to failures and frustration among the investors and has been a hindrance to aquaculture development in Kenya (Okechi 2004).

Lack of economic information on the feasibility of aquaculture has adverse effects. It affects decision making when evaluating possible investment options, accessibility to financing needed for investment and it makes insurance of such investments difficult (Pillay and Kutty 2005). These factors will impact negatively on aquaculture investment and therefore development.

Given the expected growth of the aquaculture industry in Kenya, the need to prepare extension service providers with the relevant working knowledge and skills for economic evaluation of commercial aquaculture investment is paramount. As aquaculture production in the country grows as expected, the producers will put more emphasis on increased productivity per unit value of input and the profitability of their culture practices. They will need to evaluate various investment options and strategies available to make rational decisions. Extension service providers will therefore need to keep ahead of this development to be effective.

1.3 Economic considerations for aquaculture production in Kenya

Economics deals with the issue of making choice. This results from scarcity of resources and the alternative use that can be made of them. An aquaculture investor is not only faced with the problem of making a choice between different investment options, but also between different modes of operation (Curtis and Howard 1993). It is agreed that economic considerations in the selection of an appropriate aquaculture production enterprise include its potential for economic returns (Omondi *et al.* 2001). However, little research has been done on comparative economic feasibility of different aquaculture investment options in Kenya. Most of the economic research has been based on analysis of single culture practice in isolation. For example, a partial economic analysis of polyculture of *Oreochromis niloticus* and *Clarias gariepinus* based on different feeds and fertiliser treatments, done at Sagana fish farm in Kenya, indicated profits ranging between KES 6,000 to 20,000 ha^{-1} $year^{-1}$ depending on the treatment (Omondi *et al.* 2001). This information is important to an investor who is considering different pond treatment options but not different investment options.

Okechi's (2004) study on the profitability of *Clarias gariepinus* farming in Lake Victoria Basin in Kenya indicated that this investment appears feasible. Again, this is a standalone evaluation and does not compare catfish production as an investment opportunity against other available aquaculture production opportunities.

There is, however, research information available that can be used to make investment options for the culture of *Oreochromis niloticus*. Results from the analysis of economic profitability of Nile tilapia (*Oreochromis niloticus*) production in Kenya (Aloyce *et al.* 2007), indicated that despite being economically feasible and profitable, mixed-sex culture was inferior to mono-sex culture and polyculture with catfish. The results also indicated that switching from mixed sex to polyculture culture does not add a significant amount of operational costs. Such information is useful to an investor considering the three options of tilapia culture.

Economic comparison between monoculture and polyculture of catfish indicates that polyculture is slightly better due to a higher economic rate of return. However, the net cash flow for the farmer is more or less the same. The main difference between the culture systems is in farm costs which are much higher for monoculture because formulated feed is required to cover for the protein requirements at the given production level (FAO 1996).

The present study evaluates the economic viability of culture of three important aquaculture species in Kenya to assess their viability for commercial culture under four culture practices. The evaluation was done for:

a) Monoculture of *Oreochromis niloticus* mainly done under a semi intensive system in earthen ponds
b) Polyculture of *Oreochromis niloticus* and *Clarias gariepinus*, mainly produced under a semi intensive system in earthen ponds
c) Semi intensive production of *Clarias gariepinus* juveniles in earthen ponds as bait for the Nile perch capture in Lake Victoria
d) *Oncorynchus mykiss* produced in intensive raceways and tank systems

2 MATERIAL AND METHODS

2.1 Definitions of economic evaluation indicators

One way of evaluating whether an opportunity such as a new aquaculture investment is worthwhile in the long-term, or to choosing between aquaculture opportunities which vary in size, is by using capital budgeting (Curtis and Howard 1993). Popular methods of capital budgeting include net present value (NPV), and internal rate of return (IRR) (Curtis and Howard 1993). Payback period (PBP) and the breakeven point (BEP) are also used as indicators of feasibility of investments (Pillay and Kutty 2005).

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 because cash flows will also be negative (Curtis and Howard 1993). The higher the NPV value, the more profitable an investment is.

IRR 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 (Curtis and Howard 1993). When evaluating possible investments options, it is important to remember that the NPV method is better that the IRR. Using NPV and IRR measurements to evaluate projects should ideally result in the same findings where everything else is the same. However, there are certain types of projects where using IRR will not be effective. The major limitation of IRR measurement is that it uses one single discount rate to evaluate every investment. However, discount rates do change significantly and therefore without modification, IRR evaluation will not be adequate for long-term projects for which discount rates are expected to vary.

PBP is the time required to recover the cost of an investment through the net cash revenues it generates (Curtis and Howard 1993). It is given as the investment cost of a project divided by the project's projected annual cash inflows. However, PBP analysis does not take into consideration cash flow after the payback period. Therefore, this method should only be used as a first approach at the initial stages of evaluation to give an indication of the payback period and may not be relied upon to rank investments on the basis of viability.

BEP describes how much a project must produce to cover for the total costs (Curtis and Howard 1993). At the BEP, the revenues generated by a project equal the total costs incurred. An investor will need to know this to weigh this against the production possibilities available. However, this method like the PBP should only be used as a first approach before proper evaluation is conducted because it does not show the profitability of projects.

High revenues alone do not necessarily translate into profits for the investor. A project must have the ability to clear all of its expenses and costs. Financial ratios are used to give an indication, not only of how likely a project is to return a profit, but also how that profit relates to other important investment characteristics of the project. These ratios are used to assess a business's ability to generate earnings as compared to costs

incurred during a specific operational period. They provide a comparison of profits generated and what has been invested in a project. For most of these ratios, having a higher value is an indication that the investment is good (Curtis and Howard 1993). Such ratios will include return on investment, return on equity, return on asset and operating profit margin ratio.

Return on equity (ROE) indicates how much profit an investment generates with the equity (Curtis and Howard 1993). Return on assets (ROA) is an indicator of how profitable an investment is relative to its total assets (Curtis and Howard 1993). Operating profit margin ratio (OPMR) gives an indication of how much of the gross income is actually profit (Curtis and Howard 1993). Return on investment (ROI) gives an indication of how an investment's returns relate to the total invested capital.

Entrepreneurs' knowledge of the sensitivity of their investment to aspects of production is very important. Investments are in most cases implemented based on average costs, prices, quantities and yields (Carole and Ivano 2005). Some of these aspects can be very volatile and their changes might have enormous effects on the profitability of projects. For investors to be able to make choices on where and how to invest, they need to know how likely variations on production output, cost of inputs or even changes in the market prices of the products will affect their future cash flows.

2.2 Data collection and assumptions

This evaluation was done based on aquaculture management and economic data available from Kenya. The data was sourced from ational aquaculture extension centres in Kenya and was based on research extension recommendations for aquaculture production practices in Kenya and production operation procedures from these centres. The centres were Sagana Aquaculture Centre (SAC), Kiganjo Trout Hatchery and Kisii Fry Multiplication Centre. Information from aquaculture handouts for farmers, developed by the Department of Fisheries in collaboration with the Pond Dynamics/Aquaculture Corroborative Research Support Programme of the USA (PD/A CRSP), was also used. The manual, written by Caren L.V. in 2001, is based on research conducted at the SAC and on-farm trials in Kenya. The manual, tailor made for Kenya, gave recommended pond management practices and expected results for semi intensive aquaculture of tilapia and African catfish. Other information was based on the author's experience in the aquaculture extension service, both as a trainer and a service provider.

Production characteristic data from the following four types of aquaculture production practices under evaluation was acquired:

a) Semi intensive monoculture of *Oreochromis niloticus*
b) Semi intensive polyculture of *Oreochromis niloticus* and catfish
c) Semi intensive catfish production for bait and
d) Culture of rainbow trout under intensive flow through tank system

For each of the investment type, the data included:

Capital investment cost estimates that were broken down into:

a) Cost of land
b) Cost of construction of buildings and fish production facilities
c) Cost of acquisition of equipment and machinery

Operational investment that included the cost incurred during production. These included:

a) Quantities of inputs used in production
b) Cost of inputs of production
c) Payment of salaries and wages
d) Cost of taxes, depreciation, permits and licences
e) Cost of acquisition of financing

Operational income that included:

a) Products and production quantities
b) Market price of products per unit value of product

2.2.1 Assumptions on production parameters

For the purpose of this evaluation, a monthly target production of 5,000 kg was set for each aquaculture practice. The evaluation was based on the assumption that food fish was to be marketed locally as gutted and scaled while the catfish was to be marketed at Lake Victoria region as live bait.

The evaluation was also based on the assumption that there would be enough water of the appropriate quality flowing to and from the production facilities by gravity. To get the water to the production facility, a water supply system costing MKES 0.15 was assumed for each of the enterprises.

Assumptions on production characteristics and some derivatives of these assumptions were based on information from the aquaculture handouts for farmers used in Kenya and national aquaculture extension centres. For a stocking density of 1.2 Kg m^{-2} for semi intensive production of tilapia and catfish, the manual recommend pelleted feed at ¾ ration plus fertiliser to bring the total nitrogen and phosphorus to full recommended rates. The recommended rates for fertilisation are 2 g m^{-2} every week for phosphate fertilisers and 3 g m^{-2} $week^{-1}$ for nitrogenous fertilisers. For agricultural lime, the recommendation is 20 kg per 100 m^2 (Caren 2001).

For the calculations on the stocking rates for polyculture of tilapia and catfish, the stocking rate for tilapia was taken to be 100% of the recommended stocking density and that of the catfish at 10% the stocking rate for tilapia. This is the normal practice in Kenya for the polyculture of these species.

Feeding calculations for culture of tilapia and catfish were based on the full recommended rate using the feed constituted and used at SAC. The feed is made from a mixture of wheat bran, *Caridina niloticus* and cotton seed cake. This feed is estimated to be 30% protein with a feed conversion ratio of 0.4 at a cost of about KES 22.00.

For the production of baitfish, management practices similar to those for the production of tilapia and catfish were assumed. However, the growth period of the fish to reach bait size was taken to be three months, which is the period the fish would take to reach a market size of about 30 g.
All estimates on trout production were based on information from farm records and extension information from Kiganjo Trout Hatchery in Kenya. The information gathered at the farm included: stocking rates, growth period, cost of juveniles, market weight, value of mature fish and cost and quality of feed used.

Apart from the production of baitfish, restocking of fish for all other cases was assumed to be done through the purchase of juveniles. For this reason, only the production of baitfish required estimations on the construction of a hatchery and hatchery equipment. These estimates on construction were based on the 2005 bills of quantity used during the construction of a catfish hatchery for the Kisii Fry Multiplication Centre (

Annex I table 4).

Estimates of the cost of equipments were based on the quantity of equipment needed for each particular enterprise and the prevailing market prices of the equipments at the time of this evaluation. The quantities and the corresponding cost of equipment needed for each enterprise are given in

Annex I table 5 and

Annex I table 6.

Construction of earthen fishponds in Kenya relies mostly on manual labour (Figure 2). For this reason, the cost of construction varies from region to region depending on the rate of payment for manual labour. Experience from SAC has shown that it takes about one man day to construct a 1 m^2 of a fish pond. The cost of unskilled labour in rural Kenya ranges from KES 100.00 to 200.00 per day. For the purpose of this evaluation, a value of KES 200.00 was estimated to be the cost of constructing a square metre of an earthen fishpond. This was estimated to cover the total cost of construction.

Figure 2: Use of manual labour in fishpond construction in Kenya

For the construction of trout production tanks, the following assumptions were made:

a) All tanks were taken to have an average tank depth of 1 m
b) The tanks were assumed to be made from locally available corrugated iron sheeting material (the size and cost of the iron sheet is given in

Annex I table 4)

c) Water flow into and out of the tanks was assumed to be by gravity

Based on these assumptions, the estimated cost of the tanks was put at KES 500.00 per square metre of the surface covered by the tank considering that their depths were constant. Figure 3 shows such tanks from a trout culture facility in Kenya.

Figure 3: Corrugated iron sheet tanks used in intensive trout culture in Kenya

Table 1 summarises the estimates, assumptions and some of their derivatives for fish culture characteristics used in this evaluation.

Table 1: Assumptions and estimates on pond management characteristics

Item	Unit	Tilapia monoculture	Tilapia/ catfish polyculture	Baitfish culture	Trout culture
Target production	Kg month^{-1}	5,000	5,000	5,000	5,000
Expected carrying capacity	Kg m^{-2}	1.2	1.2	1.2	20
Stocking rate	Fish m^{-2}	4	4	40	67
Cost of fingerlings/individual	KES/piece	3			15
Batch cycle length	Months	7	7	3	18
FCR of feed used	Ratio	0.4	0.4	0.4	0.5
Average harvest weight	Kg	0.3	0.6	0.03	0.3
Produce price	KES Kg^{-1}	215.00	215.00	266.67	400.00
Cost of feed	KES Kg^{-1}	22.00	22.00	22.00	40.00
Fertilisers rate DAP	Kg m^{-2} y^{-1}	0.104	0.104	0.104	
UREA	Kg m^{-2} yr^{-1}	0.156	0.156	0.156	
Cost of fertilisers	KES Kg^{-1}	21.00	21.00	21.00	
Liming rate	Kg m^{-2} yr^{-1}	0.4	0.4	0.4	
Cost of Lime	KES Kg^{-1}	3.00	3.00	3.00	
Month	Days	30	30	30	30
Year	Days	365	365	365	365
Pond/tank construction	KES m^{-2}	200.00	200.00	200.00	500.00

For the production of baitfish juveniles, the assumptions in Table 2 were used. The feeding rate for brooders was based on the FAO handbook of catfish reproduction (FAO 1996). The cost and average weight of brooders was based on information from SAC. Calculation of the number of juveniles produced per brooder was based on the author's experience in artificial catfish propagation.

Table 2: Assumptions on catfish juvenile production

Item	Unit	Value
Average weight of brooders	Kg	0.5
No of juveniles per brooder (Considering M:F)	No. of fry individual^{-1} month^{-1}	140
Feeding rate for brooders	% body weight per day	1.50%
Stocking rate for brooders	Individual m^{-2}	2
Cost of brooders	KES individual^{-1}	150

2.2.2 Assumptions of financing and other factors of production

Estimates of the cost of financing were acquired from the website of the Central Bank of Kenya (CBK 2007) and taxation rates from the website of the Kenya Revenue Authority (KRA 2007).

Table 3 and Table 4 show financing characteristics and estimates of taxation and levies.

Table 3: Financing characteristics

Item	Value
Discounting rate	6% (best interest rate of saving account in Kenya)
Interest rate on borrowed capital	15% of principal
Loan management fee	2% of borrowed capital
Equity (assumed value)	30% of needed investment capital
Loan (assumed value)	70% of needed investment capital
Repayment period (assumed value)	Nine years with one year grace period
Divided payable to equity (assumed value)	10% of profit after tax

Table 4: Estimates of taxes and levies payable

Item	Unit	Value
Income tax	% of profit	30%
Permits/ insurance and licenses	Annual	150,000.00

To calculate the cost of capital investment, the total land requirements for each investment was derived from the total pond or tank area needed to achieve the projected production depending on the stocking densities for each investment. An additional 30% for trout and 10% for the others, of the total area covered by ponds or tanks was added to cover for buildings and spaces between buildings and production units. The total land value was then calculated using an estimated land value of KES 500,000.00 per hectare. Land value in Kenya goes by prevailing market prices depending on where the land is located and on a willing buyer willing seller basis. The estimated value would apply to agricultural land in less densely populated rural areas in Kenya. The total cost of ponds or tanks was derived from the total production area needed and the estimated construction cost per square metre of pond or tank. The value of buildings, equipment, and machinery were estimated using the prevailing costs in Kenya.
Depreciations on capital investment were assumed as shown in Table 5. These values were estimated based on the expected useful life of each item using the rates given by the Kenya Revenue Authority (KRA 2007).

Table 5: Assumptions of depreciations

Item	Estimated useful life (years)	Percentage depreciation
Buildings	50	2%
Ponds and tanks	30	3%
Farm water supply system	20	5%
Equipment and machinery	7	14%

Other factors of production considered in this evaluation were costs of repairs and maintenance of equipment, ponds and buildings, cost of hired services, salaries and the cost of energy. Estimations on usage of and cost of electricity was based on rates given by Kenya Power and Lighting (KPLC 2007). These are shown in

Table 6.

Table 6: Estimations on other factors and costs of production

Item	**Unit**	**Value**
Cost of buildings repairs and maintenance	% of value yr^{-1}	1%
Cost of ponds repairs and maintenance	KES m^{-2} yr^{-1}	1%
Cost of equipment repairs and maintenance	% of value yr^{-1}	2%
Postage and telephone	KES yr^{-1}	40,000.00
Hired services	KES yr^{-1}	100,000.00
Fuel cost (diesel)	KES l^{-1}	70.00
Power	Kwh day^{-1}	100.00
Power cost	KES Kwh^{-1}	5.00
Permanent staff	Number	6
Annual salaries	KES yr^{-1}	1,080,000.00

2.3 Data analysis

Data analysis was done using MS Excel™.

Using the data, a yearly simulation of operations over a period of 10 years was done for each culture practice. A production target for each was set at a constant 5,000 kg per month to bring the total yearly production to 60 metric tons. From this production target and using the acquired and estimated production characteristic for each type of production, cost values for capital investment, operational investment, and operational incomes were calculated. This was done by generating the following statements for each of the four culture practices:

a) Investment statement
b) Operation statement
c) Cash flow statement and
d) Balance sheet

These statements were used to derive the parameters that were used in this evaluation as indicators of the viability and feasibility of the culture practices.

2.3.1 Viability of investments

The viability of the investments was estimated by analysing:

a) Net present value (NPV)
b) Internal rate of return (IRR)
c) Payback period (PBP)
d) Break-even point (BEP)

The NPV and the IRR were derived from the net cash flows by the discounting method. The PBP was calculated by dividing the initial investment costs by the accumulated profits before depreciations. This gave the time in years that the enterprise would take to pay back the initial investment cost. BEP was derived for production quantities and produce prices. BEP analysis for production quantities was derived by calculating how much each enterprise should produce per hectare, considering the estimated market prices for the products, to be able to cover the total production cost. The break even analysis for the produce prices was calculated by deriving the price at which the produce must be sold to cover the total cost of production.

In this evaluation, the BEP margin was considered in evaluation of the BEP. The margin gave an indication of how much of a 'buffer' zone an investor would have before falling to the BEP level. Wide margins, which would indicate bigger profit margins, are preferable.

2.3.2 Evaluation of financial ratios

Evaluation of financial ratios was done by deriving the following ratios:

a) Return on equity (ROE)
b) Return on asset (ROA)
c) Operating profit margin ratio (OPMR)
d) Return on investment (ROI)

For the analysis of the financial ratios of the culture practices, the derived values of these ratios were plotted in a compound bar chart for comparison. These ratios were derived as:

ROE: Net income from operations divided by total equity
ROA: Net income from operations divided by total assets
OPMR: Operational gains plus interest divided by gross income
ROI: Net income from operation divided by debts plus capital

2.3.3 Sensitivity of investments to changes in factors of production

Sensitivity of the investments was analysed by simulating changes in:

a) Produce prices
b) Cost of feed
c) Production quantities
d) Food conversion ratios and
e) Survival rates of fish species under culture

This analysis was done to determine the extent to which slight changes in the values of these production characteristic variables would influence particular dependent enterprise viability variables. Apart from survival rate, all other variables were varied between 90% and 110% of their estimated values. Survival rate was varied from 90% to 100% of the values used in this evaluation. The dependent viability variables considered were NPV and IRR. A sensitivity factor for each effect was derived from the rate of change of the values of the viability factor relative to simulated changes in the production characteristic variable in consideration. This rate of change was derived from the gradient of a straight line representing the trends in these changes as given by the equation:

$$\boldsymbol{y = mx + c}$$

Where $\boldsymbol{m}$ is the gradient and $\boldsymbol{c}$ is the $\boldsymbol{y}$ intercept.

3 RESULTS

The four aquaculture investments were simulated based on a combination of production characteristics for the fish species under consideration and estimated costs of investment. The generated economic variables were used to generate investment costs, shown in Table 7. Due to the differences in stocking rates, and therefore productivity per unit area of land and water surface, capital investment in land and production units was highest for monoculture of tilapia and polyculture with catfish. Total capital investment costs for monoculture of tilapia and polyculture with catfish were therefore similar due to similarity in their production characteristics. Their total investment costs were also the highest because their stocking densities were the lowest and thus needing much larger land size and production units to produce the projected 5,000 kg per year. Trout production had the lowest investment cost with respect to land and production units because it employed an intensive production system that required less production space compared to the semi intensive production system.

Generated statements of investments, operations, cash flows, and balance sheets for each of the four culture practices are presented in Annex II.

Table 7: Estimations of costs of capital investment (MKES)

Item	**Tilapia**	**Tilapia/ Catfish**	**Bait catfish**	**Trout**
Cost of land	1.66	1.66	0.96	0.32
Installation of farm water supply	0.15	0.15	0.15	0.15
Pond construction	5.98	5.98	3.50	2.40
Houses/Office/Store/Fish handling facility	7.50	7.50	7.50	7.50
Hatchery	0.00	0.00	0.50	0.00
Total cost of equipment and machinery	3.21	3.21	3.72	3.20
TOTAL	**266**	**266**	**346**	**169**

From the investment and financing statements, total investments, depreciations, and the repayment of borrowed capital were calculated for each enterprise. Operational gains and losses were derived from the operational statements while cash movements during the projected period were derived from the cash flow statements. Total assets and debts for each of the culture practices were derived from the balance sheets.

Table 8 shows an operational statement for the four culture practices in the 10th year of operation. Gross income for the culture practices was mainly dependent on the value of produce because the production quantity was similar for all the culture practices. Trout production therefore showed a higher gross income due to higher value of the products compared to the rest. Baitfish culture showed higher gross income compared to monoculture of tilapia and polyculture with catfish. This was because the price of baitfish per metric ton was higher than the price of either catfish or tilapia of the same weight. Due to the additional production resulting from catfish in polyculture with tilapia, polyculture had higher gross income compared to monoculture. Sales and therefore income in trout production was not realised until after 18 months from the initial stocking. Monoculture of tilapia and polyculture with catfish started generating income six months after the initial stocking while baitfish culture took three months. Therefore, in trout production, higher initial operation capital was required to cover for operations during the 18 month period, which meant that more capital was borrowed, compared to the other culture practices. This raised the cost of financing and therefore total production cost for this enterprise. The total cost in trout production was also raised by the higher cost of feed and juveniles. Baitfish production had higher variable costs compared to monoculture of tilapia and polyculture with catfish. This resulted from the cost of maintaining the brood stock. Due to the extra costs incurred in the purchase of catfish juveniles in polyculture of tilapia and catfish, this culture practice showed higher variable costs than monoculture of tilapia.

All the culture practices showed a positive operational surplus available for continued operations and positive net profits although in varying amounts. Trout production had a higher operating surplus compared to the rest indicating that although its total production cost was higher, the gross income generated was high enough to cover for all costs and still have higher operational surplus available for continued operations. Monoculture of tilapia had the least surplus compared to the others.

Due to higher investment costs incurred in putting up production units, total depreciation was higher for the monoculture of tilapia and polyculture with catfish compared to baitfish and trout production.

Overall, trout production had much higher accumulated profits compared to the other culture practices in the 10th year of operation. This was followed by baitfish production, polyculture of tilapia and catfish and lastly monoculture of tilapia.

Table 8: Operation statements for the investments in the 10th year of operation (financial values in the table are shown in million Kenya Shillings (MKES))

Culture practice	Tilapia monoculture	Tilapia/catfish polyculture	Catfish bait culture	Trout culture
Sales quantity (tons year^{-1})	60.00	70.08	60.00	60.00
Sales Price (MKES ton^{-1})	0.215	0.215	0.267	0.400
Gross Income	**12.90**	**15.07**	**16.00**	**24.00**
Variable Cost (MKES ton^{-1})	4.92	5.65	6.28	9.15
Fixed costs	2.95	2.99	2.81	3.75
Total cost	**7.86**	**8.64**	**9.09**	**12.90**
Operating surplus (EBITDA)	**5.04**	**6.43**	**6.91**	**11.10**
Depreciation	0.35	0.35	0.28	0.23
Operating gain/loss	**4.68**	**6.08**	**6.63**	**10.87**
Interest and loan management fee	0.27	0.28	0.25	0.39
Profit before tax	**4.41**	**5.80**	**6.38**	**10.48**
Taxable profit	4.41	5.80	6.38	10.48
Income tax	1.32	1.74	1.91	3.14
Profit after tax	**3.09**	**4.06**	**4.47**	**7.34**
Dividend	0.31	0.41	0.45	0.73
Net profit/loss	**2.78**	**3.66**	**4.02**	**6.60**
Profit+depreciation	3.44	4.41	4.75	7.57
Accumulated Profit+depreciation	**26.88**	**36.35**	**40.85**	**47.50**

3.1 Viability analysis

Enterprise viability analysis was based on the evaluation of NPV, IRR, PBP and BEP for each of the culture practices. Accumulated net cash flows generated from the cash flow statements (Annex II) were used to derive the NPV and IRR values for each of the culture practices as represented in Figure 4.

The analysis showed that the derived values for NPV and IRR for the four culture practices were positive indicating that all the culture practices were viable although at varying degrees. Bait catfish culture had the highest values for NPV and IRR indicating the highest viability in this evaluation. Polyculture of tilapia and catfish had the next best values for NPV and IRR while monoculture of tilapia showed the least viability based on NPV value derived. Trout culture showed the least value for IRR but based on its NPV value, it was more viable than monoculture of tilapia.

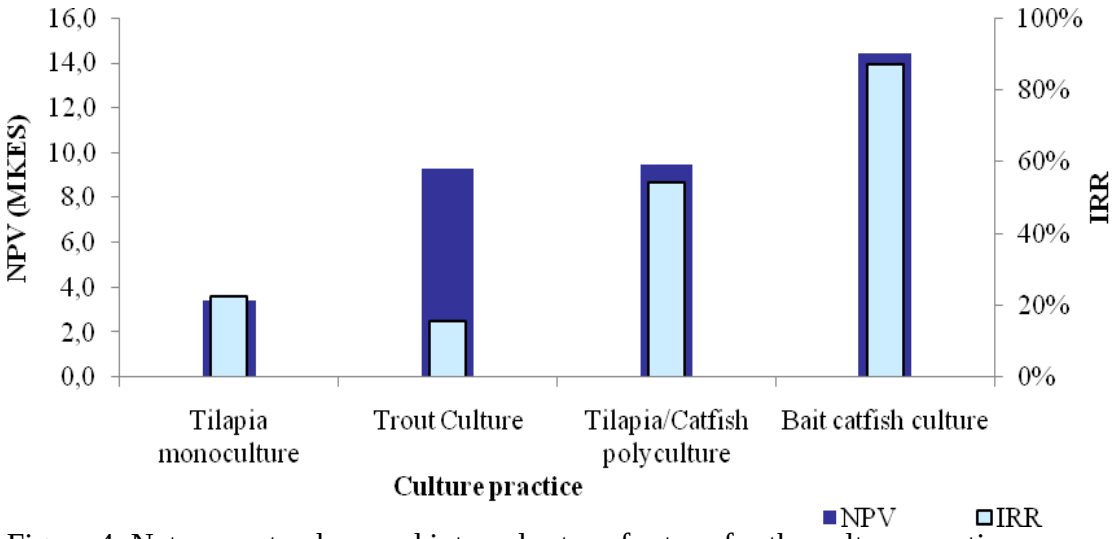

Figure 4: Net present values and internal rates of return for the culture practices

The higher the NPV value, the more viable is the investment.

PBP analysis indicated that baitfish culture had a payback period of 4.5 years, which was the shortest period in this evaluation. The other culture practices had 5.3 years for trout culture, 5.8 years for polyculture of tilapia and catfish, while the monoculture of tilapia had the longest period of 7.5 years.

Table 9 summarises the viability of the culture practices according to their NPV, IRR and PBP values. The culture practices are ranked according to their NPV values which is the best measure for economic viability.

Table 9: Viability ranking based on NPV, IRR and PBP

Culture practice	**NPV (MKES)**	**IRR**	**PBP (years)**
Baitfish culture	14.4	87%	4.5
Tilapia-catfish polyculture	9.5	54%	5.7
Trout culture	9.3	16%	5.3
Tilapia monoculture	3.4	22%	7.5

Figure 5 shows the results for BEP analysis for production quantities. These results indicated that trout production had both the highest BEP and biggest BEP production margin while monoculture of tilapia had the lowest values for the same.

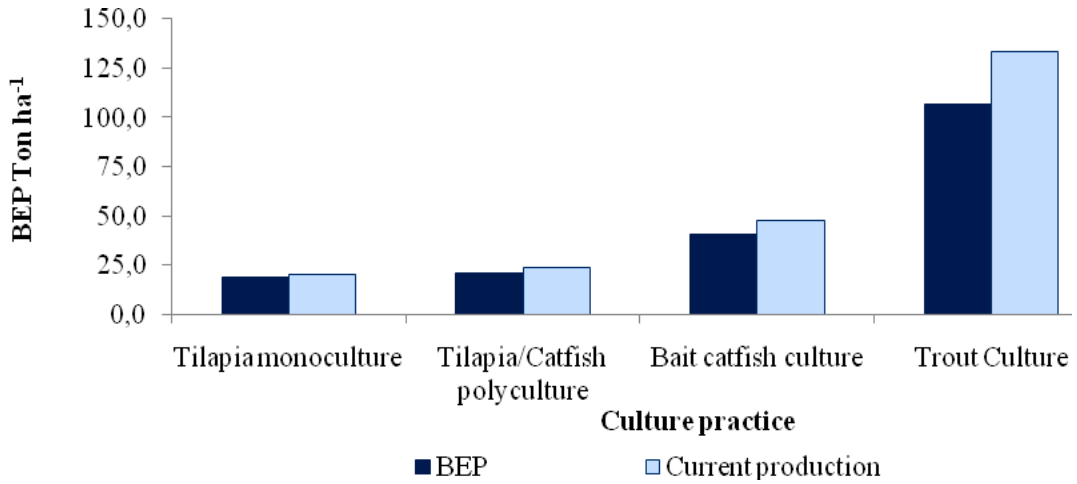

Figure 5: Derived break-even point for production for the culture practices compared with the current production to give the break-even margin for production.

The analysis for the BEP for price of produce (Figure 6) indicated that trout production had the highest BEP value and the biggest BEP margin for produce price.

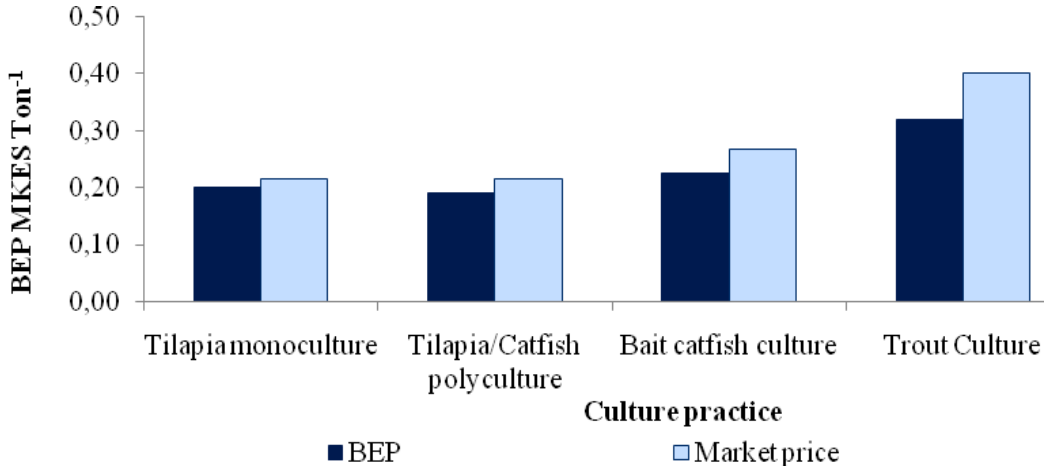

Figure 6: Derived break-even point for price of products for the culture practices compared with the current market price to give the break-even margin for sales price.

The results of the BEP analysis are summarised in Table 10 showing the ranking of the culture practices according to their BEP values from the highest to the lowest.

Table 10: Culture practices ranked by BEP and BEP margins

Culture practice	**BEP production tons ha^{-1}**	**BEP margin tons ha^{-1}**	**BEP price MKES ton^{-1}**	**BEP margin MKES ton^{-1}**
Trout culture	106.5	26.8	0.32	0.08
Baitfish culture	40.7	7.3	0.23	0.04
Tilapia-catfish polyculture	21.2	2.8	0.19	0.02
Tilapia monoculture	19.2	1.4	0.20	0.02

3.2 Financial ratios analysis

For this analysis, all culture practices showed positive values for the financial ratios analysed (Figure 7). Trout production showed the best combination for the ratios. It indicated the highest return to investment, equity and assets compared to the other three. Its OPMR, was lower than that of both baitfish and polyculture production indicating that more of its gross income goes to operations as compared to the two. Production of baitfish had the next best combination for these ratios while monoculture of tilapia showed the lowest among the culture practices in this evaluation.

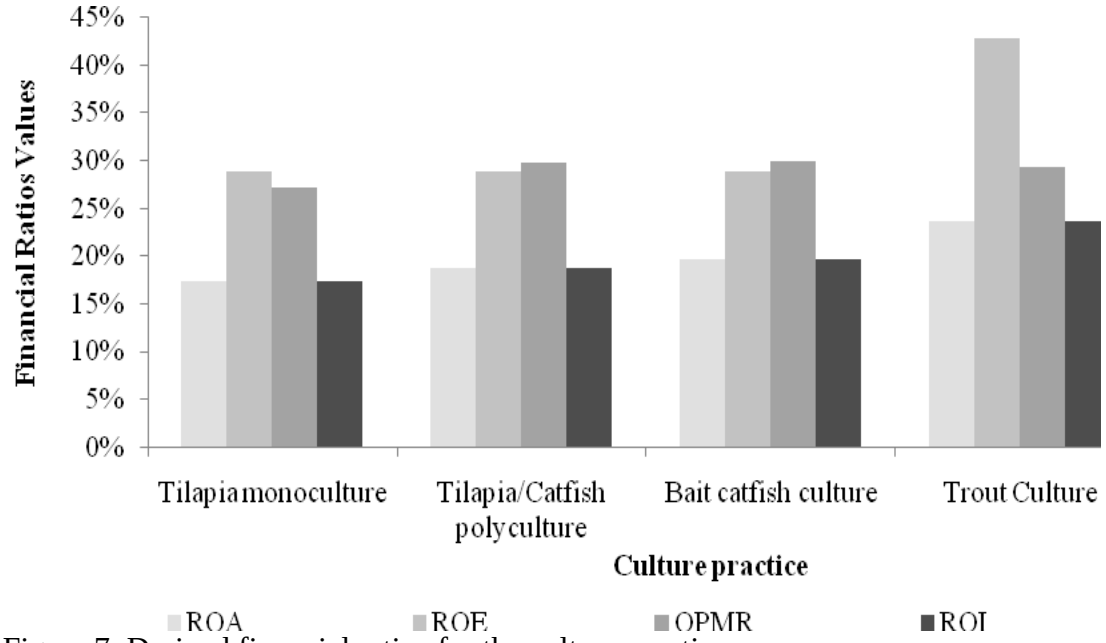

Figure 7: Derived financial ratios for the culture practices

3.3 Sensitivity analysis

The production characteristics variables considered for this analysis were:

a) Produce prices
b) Cost of feed
c) Production quantities
d) Food conversion ratios (FCR) and
e) Survival rates of fish species under culture

The dependent enterprise viability variables considered were NPV and IRR.

3.3.1 Effects of changes in the produce price on NPV and IRR

Both NPV and IRR values varied directly proportionally to the changes in the prices of the produce. An increase in produce prices caused a subsequent increase in the values of both NPV and IRR for all cases evaluated while a decrease in prices caused a decrease in the values of both NPV and IRR.

NPV of trout production showed the highest sensitivity with a sensitivity factor of 2.2 while that of monoculture of tilapia with a factor of 1.34 was the least sensitive. When the produce prices were lowered by 10%, the NPV of both trout and tilapia production indicated negative values while that of polyculture was close to zero. Figure 8 shows the effects of changes in produce price to NPV values of the evaluated culture practices.

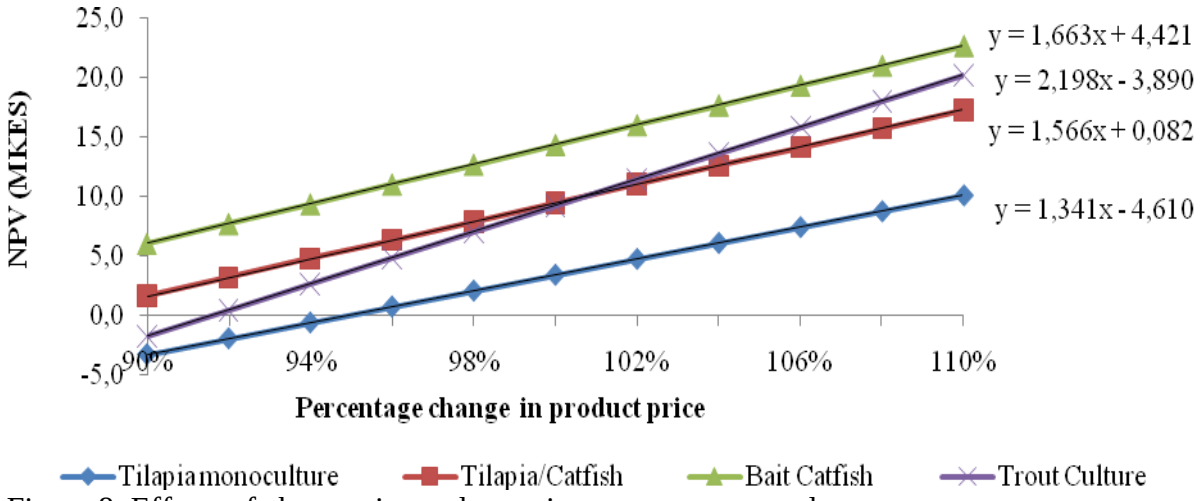

Figure 8: Effects of changes in produce price on net present value

Figure 9 shows the effects of changes in the price of produce on IRR. The analysis showed that the IRR of bait catfish production with a sensitivity factor of 0.17 was the most sensitive to these variations while trout production with a factor of 0.02 was the least sensitive. Polyculture of tilapia and catfish and monoculture of tilapia had sensitivity factors of 0.14 and 0.077 respectively. While a reduction of produce price by 10% reduced the IRR values of all the culture practices, the IRR value of monoculture of tilapia went below zero.

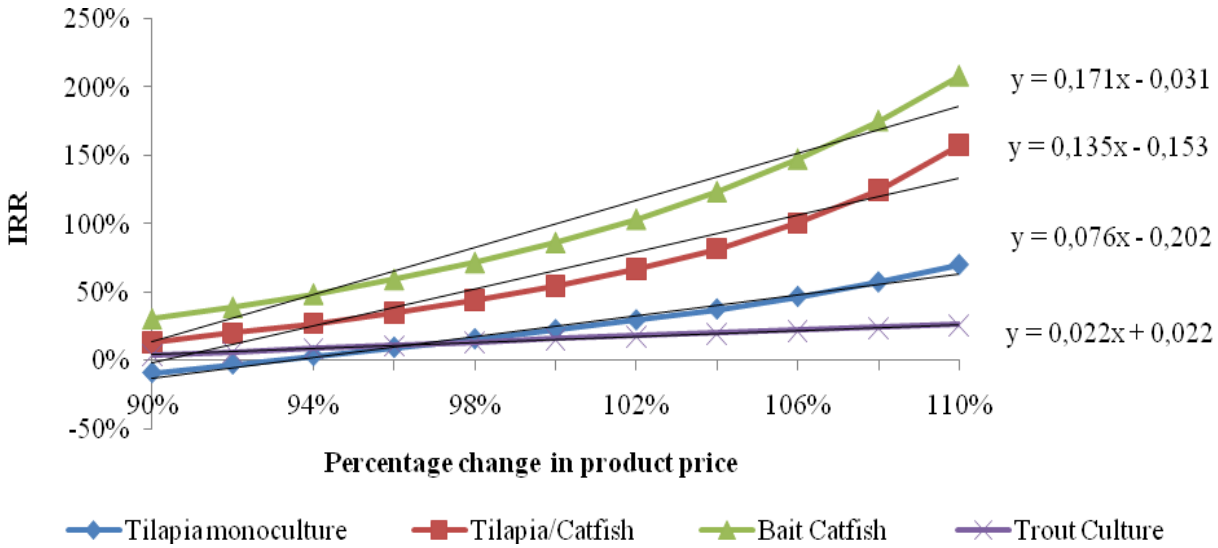

Figure 9: Effects of changes in produce price on internal rate of return

3.3.2 Effects of changes in the cost of feed on NPV and IRR

Changes in the cost of feed were shown to have a negative effect on both the NPV and IRR values of the evaluated culture practices. An increase in the price of feed resulted in a subsequent decrease in the values of these two viability factors.

Figure 10 shows the effects of changes in the cost of feed on the NPV of the culture practices evaluated. The analysis showed that polyculture of tilapia and catfish, with a sensitivity factor of -0.55 was the most sensitive. The NPV for monoculture of tilapia showed the least sensitivity with a factor of -0.47. When the cost of feed was increased by 10%, the NPV value for monoculture of tilapia was reduced to 0.8 which was the lowest compared to the others.

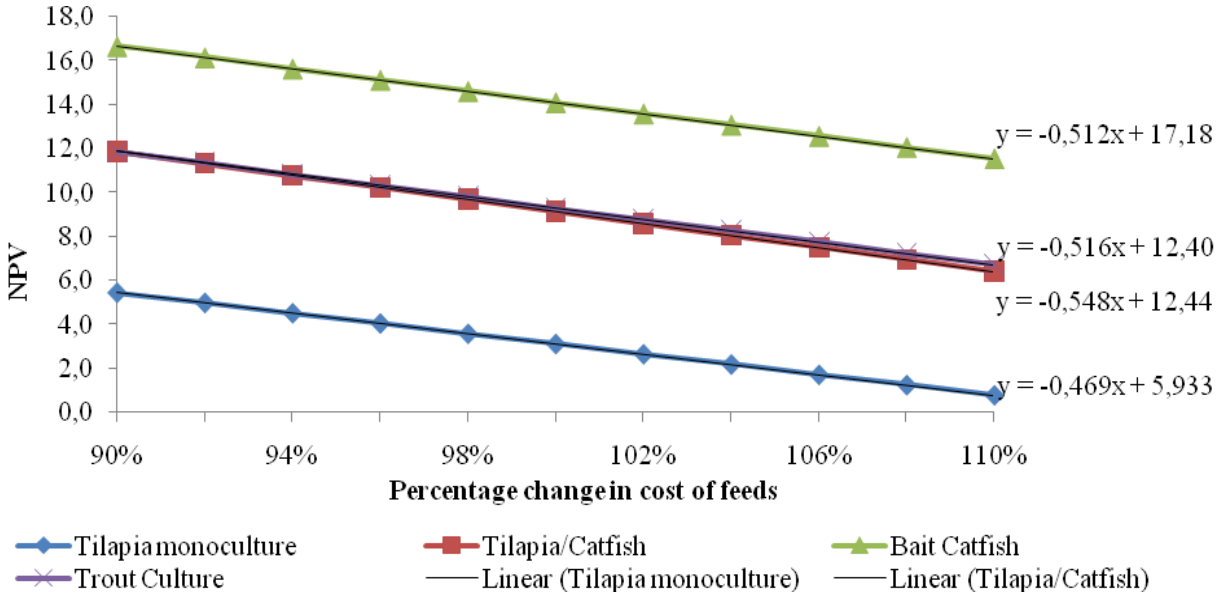

Figure 10: Effects of changes in the cost of feed on net present value

Figure 11 shows the effects of changes in the cost of feed on the IRR of the culture practices. The IRR of baitfish production showed the highest sensitivity with a sensitivity factor of -0.062 while that of trout culture with a factor of -0.006 was the least sensitive. An increase in the cost of feed by 10% reduced the IRR values of both trout and tilapia culture to the lowest level compared to the other culture practices while that of baitfish production remained the highest with the same magnitude of increase in feed prices.

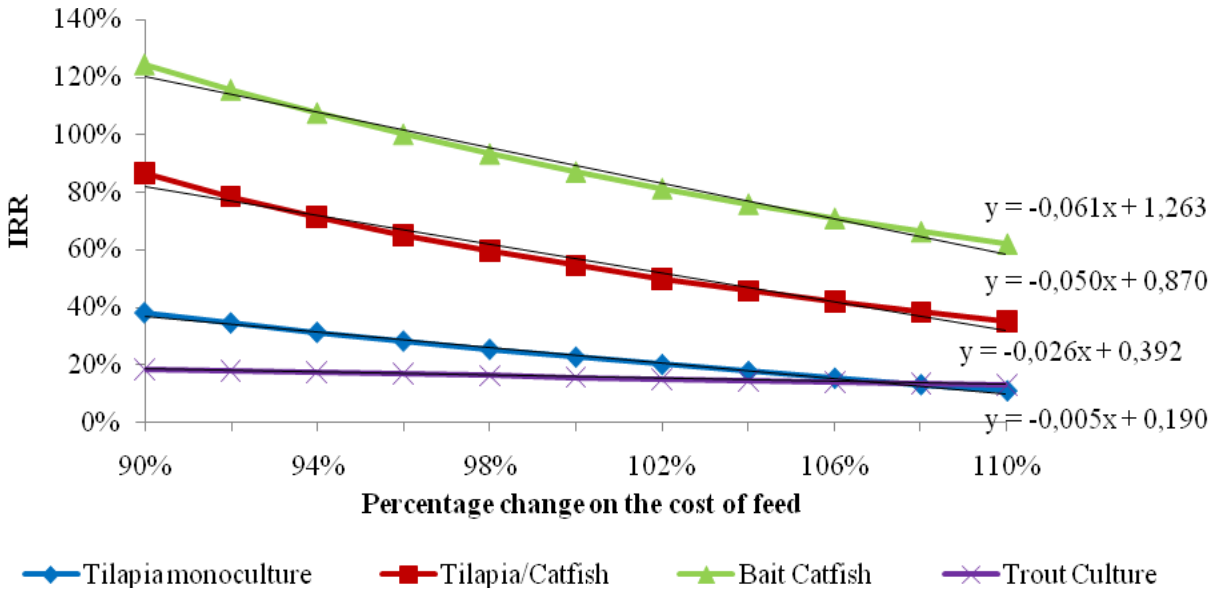

Figure 11: Effects of changes in the cost of feed on the internal rate of return

3.3.3 Effects of variations in production output on NPV and IRR

The analysis showed a positive relationship for both the NPV and IRR in changes in the production volumes. An increase in production output resulted in a subsequent increase in both NPV and IRR for all culture practices.

Figure 12 shows the effect of changes in production output on the NPV of the culture practices evaluated. Trout production indicated a sensitivity factor of 1.21, which was the highest for the evaluated culture practices. The least sensitive was monoculture of tilapia which showed a factor of 0.57. Baitfish production and polyculture of tilapia and catfish showed sensitivity factors of 0.80 and 0.69 respectively. A reduction in production volume by 10% resulted in a reduced NPV value of tilapia production from 3.1 to 0.3 which was the lowest for the evaluation.

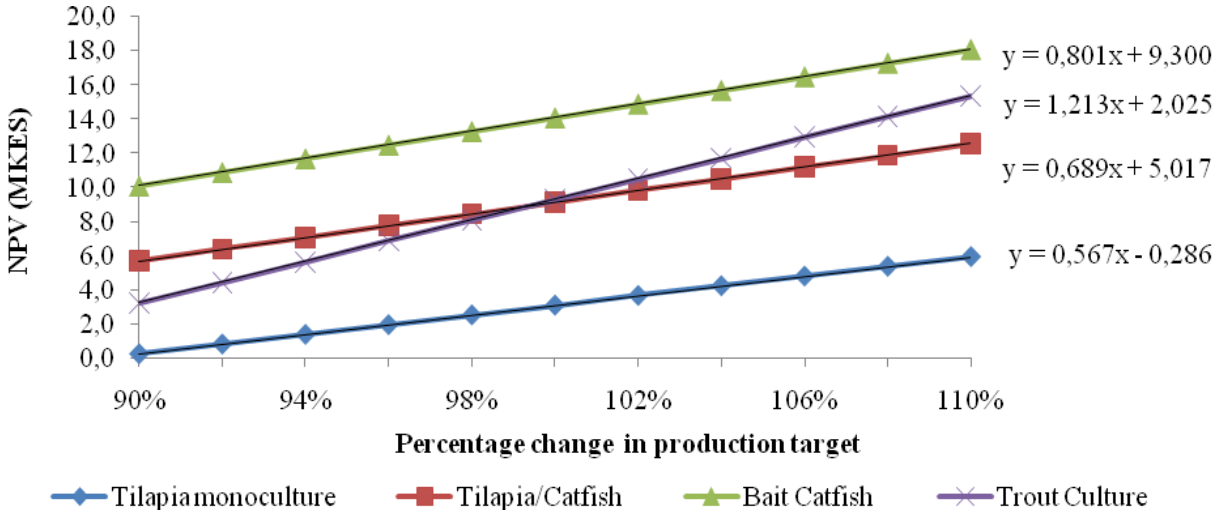

Figure 12: Effects of changes on production quantity on net present value

Figure 13 shows the effects of changes in production output on the IRR of the culture practices evaluated. Baitfish production indicated a sensitivity factor of 0.055, which was the highest. The least sensitive was trout production with a factor of 0.011. Monoculture of tilapia and polyculture of tilapia and catfish showed sensitivity factors of 0.027 and 0.039 respectively. However, for a reduction in the produce quantity by 10%, the tilapia and trout culture had the lowest IRR value.

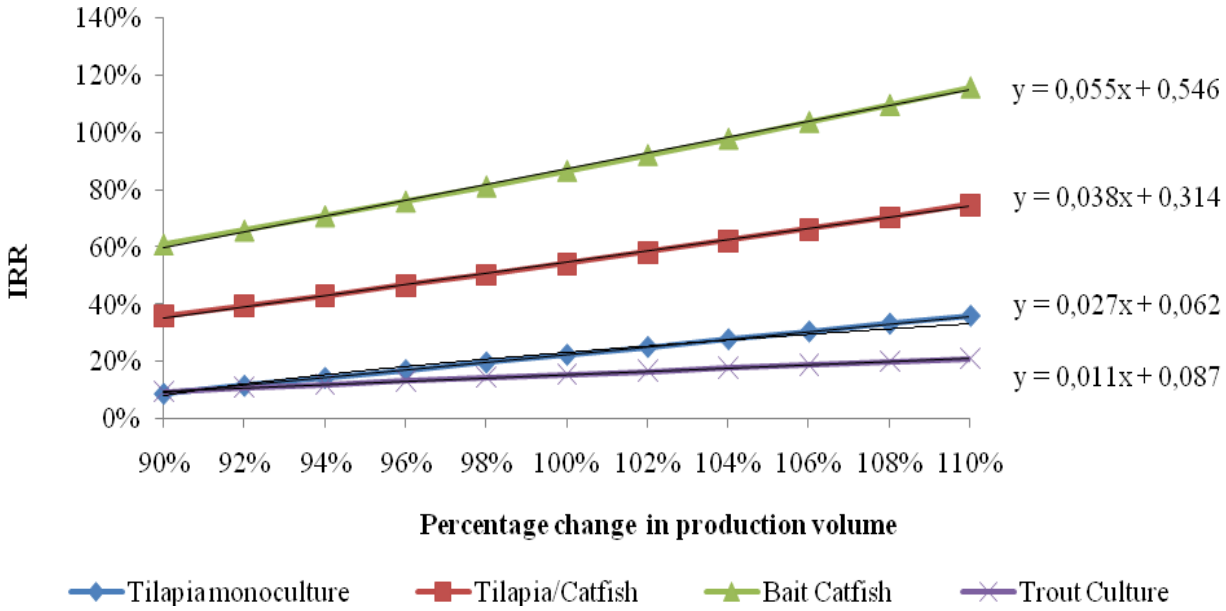

Figure 13: Effects of production quantity on the internal rate of return

3.3.4 Effects of changes in FCR on NPV and IRR

This analysis showed that incremental changes in FCR caused similar changes in both the NPV and IRR for all the culture practices. As the FCR of the feed increased, there was a corresponding increase in the NPV and IRR values of the culture practices.

Figure 14 shows these effects on NPV. The effects were shown to be more pronounced for the NPV of polyculture of tilapia and catfish with a value of 0.55. Baitfish culture had a value of 0.44, trout production a value of 0.52. and monoculture of tilapia a value of 0.47. Reducing the FCR of the feed by 10% reduced the NPV value of the tilapia culture from 3.1 to 0.5, which was the lowest viability value.

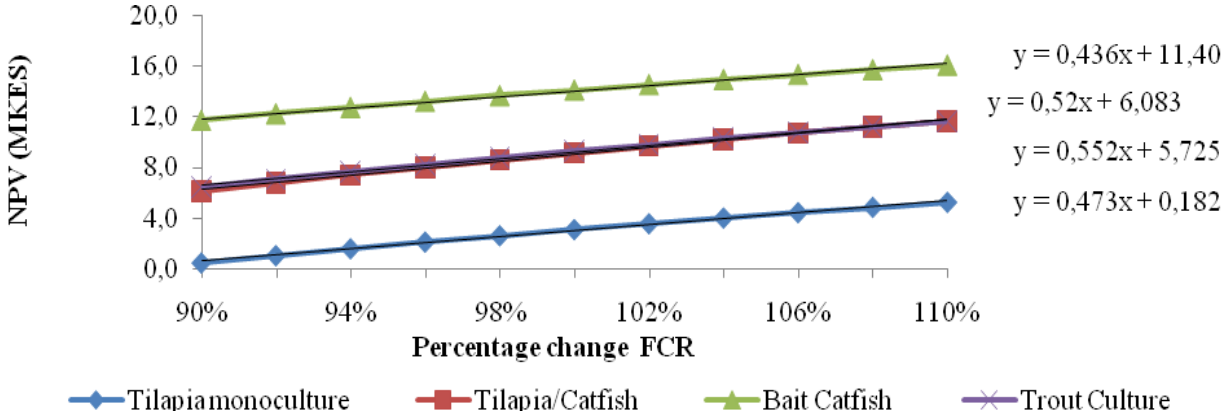

Figure 14: Effects of changes in the feed conversion ratio on net present values

The effects of changes in FCR on IRR (Figure 15) were shown to have similar trends as those on NPV. As the FCR of the feed improved, the IRR vales for the culture practices increased. The highest effect was seen in the culture of baitfish that had a sensitivity value of 0.051. The IRR for the polyculture of tilapia and catfish had a value of 0.049, monoculture of tilapia a value of 0.027 and trout culture a value of 0.006.

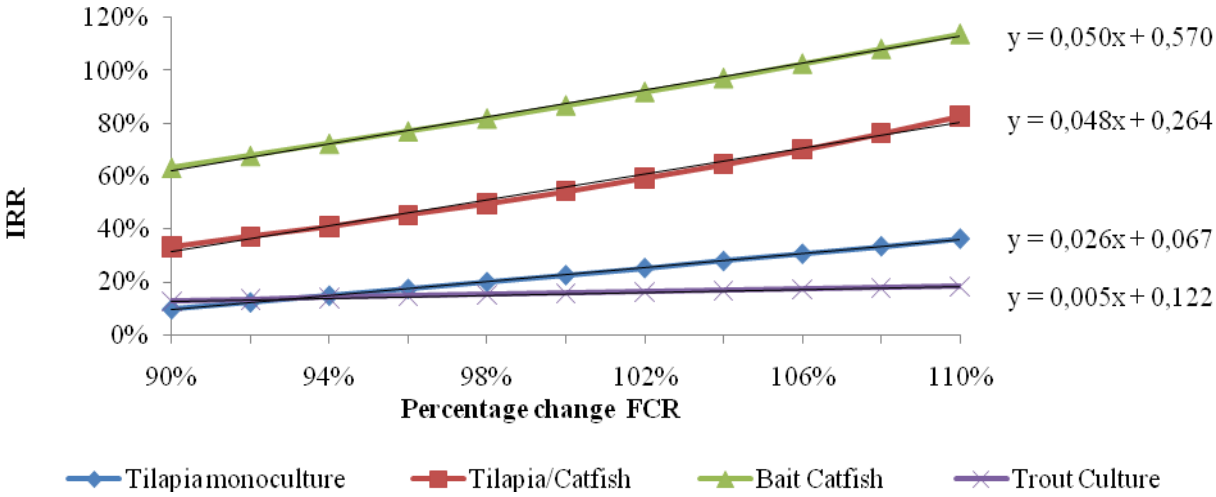

Figure 15: Effects of changes in feed conversion ration on internal rate of return

3.3.5 Effects of changes in survival rate on NPV and IRR

This analysis showed that NPV and IRR values of all the culture practices changed in direct proportion with changes in the survival rate of the fish species under culture.

Figure 16 shows the effects of changes in the survival rate of fish cultured on the NPV. Trout culture showed the highest sensitivity with a factor of 0.24. Baitfish culture had the next highest value, 0.14 followed by culture of tilapia, 0.08 and polyculture of tilapia and catfish, 0.07.

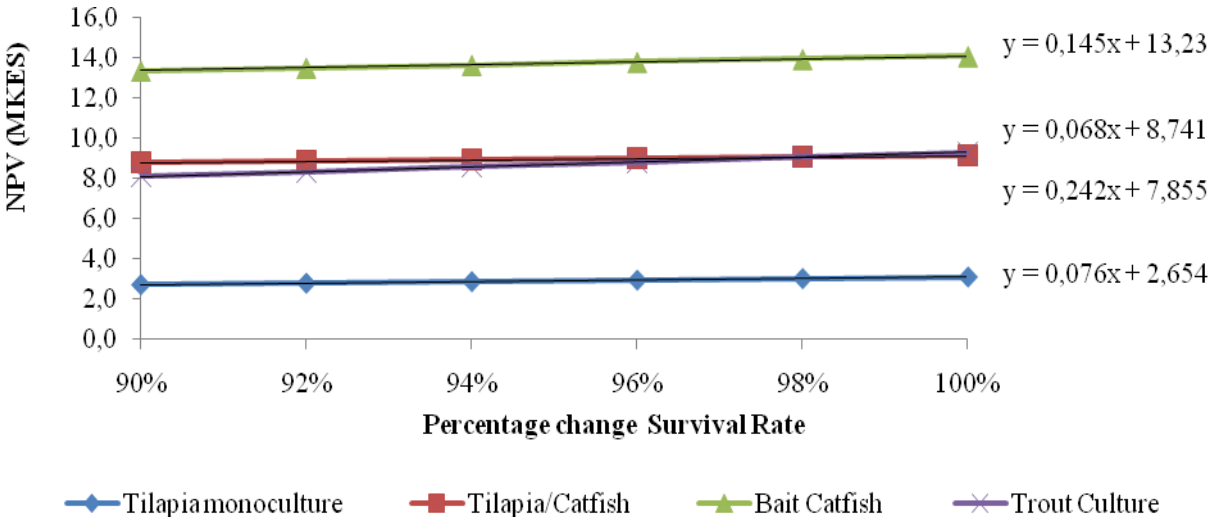

Figure 16: Effects of survival rate on net present value

The NPV show a minimal decrease as the survival rate decreased.

The effects of changes in the survival rate of fish to IRR were shown to be similar to those on NPV. As the survival rate increased, the IRR values increased. Figure 17 shows the results of this analysis. Baitfish culture had the highest sensitivity value, 0.017 followed by polyculture of tilapia and catfish. Monoculture of tilapia and trout culture had values of 0.004 and 0.003 respectively.

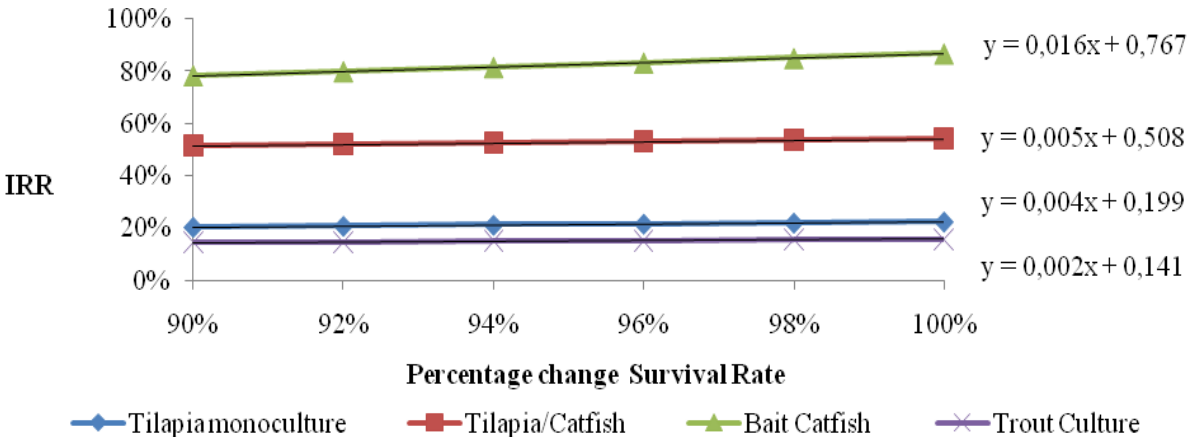

Figure 17: Effects of survival rate on internal rate of return

Overall, produce price had the greatest effects on the viability of all the evaluated culture practices while the survival rate had the least effects. Trout production showed the greatest sensitivity to changes in factors of production compared to the rest of the evaluated culture practices while monoculture showed the least sensitivity. This is summarised in Figure 18 and Figure 19, which give the sensitivity factors of the evaluated factors of production on the NPV and IRR of the culture practices.

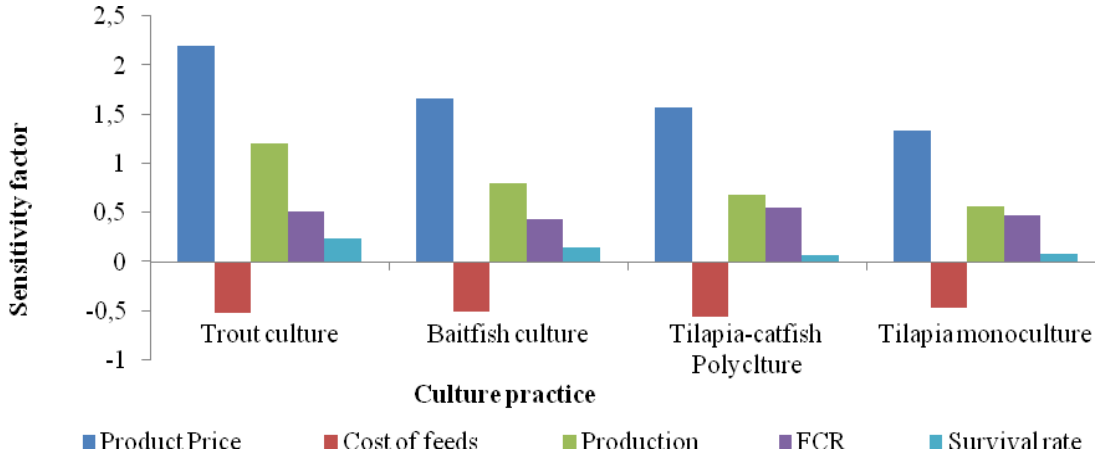

Figure 18: Summarised sensitivity factors on net present value of the culture practices

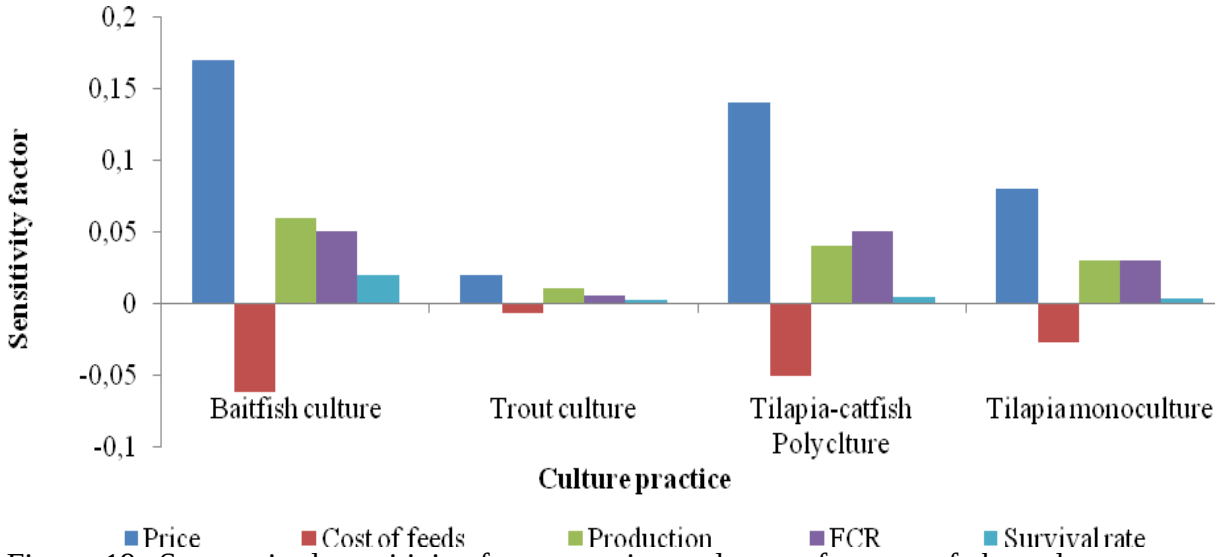

Figure 19: Summarised sensitivity factors on internal rate of return of the culture practices

4 DISCUSSION

Based on the estimates of the present study, the results indicated that all the culture practices evaluated were viable even in the long term although at varying degrees. They all had positive values for NPV, which is a strong indicator of economic viability. Their IRR and financial ratios were also positive. The viability was also indicated by their positive values for operating surplus and net profit in the 10th year of operation. All had BEPs below their production levels and market prices of products, and their PBP for all was within the evaluation period.

In order of viability based on the NPV values, this evaluation ranked the evaluated culture practices as follows: baitfish production, polyculture of tilapia and catfish, trout production and monoculture of tilapia. Catfish for the bait industry showed the highest viability of the four considered. It had the best NPV and IRR values. This can be explained by its higher turnover rate compared to the other culture practices. It takes three months to grow the fish to bait size while it takes seven months for monoculture of tilapia and polyculture of tilapia and catfish to reach market size while trout takes 18 months. Baitfish culture viability was also the safest from adverse fluctuations in the factors of production. Its viability factors (NPV and IRR) remained the highest for all the culture practices when adverse effects were simulated on factors of production.

Although the culture of baitfish showed the best viability, it has a limited production zone confined to the Lake Victoria region and is dependent on the Nile perch fisheries of the lake for its market. However, analysis of fish production data from Lake Victoria between 1999 and 2002 indicated an accumulative decline in fish production by 43% (Makogola 2005). Nile perch makes up 90% of the fish production from the lake. Therefore, an investor considering baitfish production will need to take into consideration the diminishing market and the limited production zone.

Commercial aquaculture in Kenya involves the culture of tilapines and the African catfish under semi intensive systems either as monoculture or polyculture of the two (Mbugua 2002). Polyculture of *Oreochromis niloticus* and catfish showed the second best values for NPV indicating that it is more viable than both trout production and monoculture of *Oreochromis niloticus*. However, monoculture of *Oreochromis niloticus* and polyculture with catfish had the smallest values for BEP and BEP margins for both production and price. Considering that, both showed high sensitivity of profitability to produce prices, cost of feed and production volumes, slight changes that would lower production volumes, increased feed prices or lower market prices of produce might result in losses for the producers. This was especially so for the monoculture of *Oreochromis niloticus*. Adverse changes on these factors of production lowered the profitability of the *Oreochromis niloticus* culture much more than for the other culture practices. When the produce price was reduced by 10%, monoculture of *Oreochromis niloticus* was no longer viable. This could be a good indication of the reason why aquaculture in Kenya has failed to develop. It can explain the frustrations and failures that the producers face.

Trout production indicated the best values for financial ratios, BEP and BEP margins for both the production volume and product price. However, because of its high BEP for production, it may not be suitable for small-scale producers who may not be able to reach this BEP. Apart from this, production of trout is faced with other problems. Lack of feed is an issue to consider especially for small-scale producers. Currently, all main producers of this fish make their own feed, which may not be available to the small-scale producers. Production of the fish is also limited to highland areas where water quality is suitable for its culture. However, most of the highly successful and labour-intensive horticulture and floriculture farming development activities are taking place in the same areas increasing competition for water (UN 2005). Coupled with the deteriorating water quality due to deforestation, zones suitable for trout production are becoming less and less available. All this diminishes opportunities for the economic culture of trout in Kenya and an investor intending to invest in trout production will need to consider these issues.

The viability of all the evaluated investments showed sensitivity to the various factors of production. This means that if investors optimised these factors of production, their investments would respond by improved viability and profitability. The investors could find ways and means of optimising productivity per unit value of input, which would lead to reduced production costs, increased BEP margins and investment viability and profitability.

Economic viability of the evaluated aquaculture practices was mainly based on their NPV using information from a few selected fish farms in Kenya and recommendations from aquaculture extension manuals available. There are, however, other considerations that were not covered in this evaluation, that are of great importance to the economic viability of such investments. The effects of diseases and parasites, predation, water quality and quantity and market forces are issues that an investor will need to look at before making a decision. Indications of some such issues are summarised in

Table 11 to give a general overview of how the culture practices score in Kenya.

Table 11: Other important considerations for the investment options

Culture practice	Local market	Local market prices	Availability of production inputs	Production zones in Kenya	Effects by environmental changes	Availability of local expertise
Baitfish culture	Limited	Good	Good	Limited	Minimal	Good
Polyculture of tilapia and catfish	Good	Fair	Good	Good	Minimal	Good
Trout culture	Limited	Good	Poor	Limited	Great	Poor
Monoculture of tilapia	Good	Fair	Good	Good	Minimal	Good

5 CONCLUSION

The results of this evaluation showed that all the culture practices evaluated were viable although there were differences in profitability. Their viability and profitability showed high sensitivity to produce prices, production volumes, cost of feed and FCR. This therefore means that efforts directed towards enhancing these factors of production, in a way that they would influence the viability of the culture practices positively, would lead to amplified returns to the investors. Better feed with higher FCR values combined with efficient feeding techniques would result in lowered feed costs per unit value of fish produced. Productivity could be increased by use of better yielding fish breeds and efficient production techniques. This would have an effect of lowered production costs and increased production volumes. These would be reflected in terms of higher viability and profitability of the culture systems.

The success of the development sustainable aquaculture in Kenya lies in the promotion of aquaculture as a viable investment opportunity where potential investors see opportunities to make attractive economic gains. The Department of Fisheries of Kenya must back this promotion by spearheading the development of higher yielding, market oriented aquaculture species and efficient aquaculture production technologies.

However, serious investors in aquaculture will only invest when they believe they can make profits. They will therefore need economic indicators to assist them in making their decisions. For this reason, the Department of Fisheries needs to have such information. The information needed should include:

a) Aquaculture production by species
b) Aquaculture productivity by culture systems
c) Available fish markets, estimated demand, supply, and corresponding prices offered
d) Sources and costs of aquaculture inputs

The Department will therefore need to impress on all those who are involved in the fisheries industry, the need for proper record keeping and must devise efficient means of collecting, storing, and analysing this information.

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6 ANNEX I: Basis of production and investment assumptions

Annex I table 1: Recommended pond management practice
These are recommendations for semi intensive production of Tilapia and African catfish

Management you intend to practice	**Expected capacity**	**Number of fish to stock per square meter pond surface**			
(See sheets on feeding and fertilizing to find recommended rates).	(kg per 100 m^2)	**150 g**	**200 g**	**300 g**	**400 g**
1. Composting, grasses and small amounts of manure.	15 kg	1	0.75	0.5	0.38
2. Chemical fertilizers at maximum recommended rate.	25 kg	1.7	1.25	0.83	0.6
3. Manure and feed such as bran.	40 kg	2.7	2	1.3	1
4. Our best management practice: bran at ½ recommended rate plus chemical fertilizer at full recommended rate.	70 kg total 60 of tilapia; 10 of clarias	4.7	3.5	2.3	1.75
5. Pelleted feed at ¾ ration plus fertilizer to bring total N and P to full recommended rate.	Estimated at 120 kg	8	6	4	3

(Caren L.V. 2001)

Annex I table 2: Production characteristics for *Oreochromis niloticus* and African catfish

Item	Unit	Value
Oreochromis niloticus juvenile cost	KES	3
Catfish juvenile cost	KES	4
Survival rate of *Oreochromis niloticus*	%	80
Survival rate of catfish from fingerling to market size.	%	60
From fry to fingerling	%.	50
Oreochromis niloticus price (at Sagana)	KES/Kg	180
Catfish price (at Sagana)	KES/Kg	180
Fillet price (at Sagana)	KES/Kg	240
Feed used wheat bran, mixture of wheat bran, *caridina* sp and cotton seed cake)	% crude protein	30
Cost of feed Farm formulated diet with 30% protein	KES/Kg	22
FCR of feed used difficult to calculate because of natural food. (Estimated)		Between 2 to 4
Pelleted diet cost	KES/Kg	30
Av. Individual harvest weight of *Oreochromis niloticus*	g	250
Av. Individual harvest weight of catfish	g	900
Ponds construction cost/m sq	KES	250
Casual labour cost/day	KES	150

Source: Sagana Aquaculture Centre (Kenya)

NB: Price of tilapia in Nairobi (Capital city of Kenya) is KES 300.00 per kg. (DoF 2007)

Annex I table 3: Production characteristics for trout culture

- Carrying capacity – 15 kg -280 kg/m^3 depending on the water quality and husbandry method in use.
- At Kiganjo hatchery we use 20-25 kg/m^3
- Initial stocking weight – 5-10 grams per juvenile
- Cost of fingerling KES 5.00 per inch
- Recommended juvenile stocking size is 3 inch
- Survival rate – 75%
- FCR- 1:2;(1=body weight, 2= food weight)
- Cost of feed – KES. 42.00 kg
- .Average growth rate – 1.8 grams per day.
- Growth period – 18 months to table size.
- Harvest weight – 250-300 grams table size.
- Average price- KES.350.00/kg (Government rate which is below market price which can go up to KES 550.00/kg).

Source: Kiganjo Trout Hatchery, Kenya

Annex I table 4: Bill of quantity from Kisii Fry Multiplication Centre

These are the actual figures of quantity and cost of items used during the construction of the centre's hatchery in 2005

S/ No:	ITEM	QUANTITY	UNIT COST (KES)	TOTAL COST (KES)
1.	Bricks	2,000	8.00	16,000.00
2.	Sand	28 tons	1,200.00	33,600.00
3.	Ballast	7 tons	1,500.00	10,500.00
4.	Cement	50 bags	800.00	40,000.00
5.	Water proof cement	50 kg	70.00	3,500.00
6.	Timber	300 metres assorted	45.00	13,500.00
7.	GI pipe 0.5 inch diameter	48 metres	200.00	9,600.00
8.	Gate valves 0.5 inch	10	250.00	2,500.00
9.	Assorted joints	20	25.00	500.00
10.	Iron sheet 3 metres	20	700.00	14,000.00
11.	Transparent iron sheet	1	1,200.00	2,400.00
12.	Twisted bars (Y 10)	14 pieces	500.00	7,000.00
13.	Binding wire (R6)	2 pieces	250.00	500.00
14.	Binding wire	10 Kg	50.00	500.00
15.	Door and frame	1	4,500.00	4,500.00
16.	Hard core	7 tons	1,200.00	8,400.00
17.	Labour			48,000.00
18.	Contingencies	10%		21,500.00
	GRAND TOTAL:			**236,500.00**

Source: Kisii Fry Multiplication Centre, Kenya

Annex I table 5: Estimates for equipments; tilapia, polyculture and trout
The equipment and their estimated costs needed in tilapia, polyculture and trout production

Fish ponds equipment	**Quantity(No.)**	**Unit Cost KES**
Secci disc	4	250
Water quality kit	1	25,000
Mature fish scoop nets	5	350
Seine nets	4	20,000
Fish buckets	10	550
Fish baskets	10	550
Feed buckets	10	550
Bins	5	700
Lawn mowers	1	150,000
Juvenile handling facility		
Basins	10	250.00
Buckets	10	250.00
Fingerlings scoop nets	4	150.00
Fish fry scoop nets	4	150.00
Thermometers	2	100.00
Dissecting kits	2	500.00
weighing scale	2	10,500.00
Computer/printer	2	150,000
Others	1	100,000
Farm trucks	1	2,500,000

Annex I table 6: Equipment and estimated costs for the baitfish production

Equipment and machinery		
Fish ponds equipment	**Quantity (No.)**	**Unit Cost KES**
Secci disc	4	250
Water quality kit	1	25,000
Mature fish scoop nets	5	350
Seine nets	4	20,000
Fish buckets	10	550
Fish baskets	10	550
Feed buckets	10	550
Bins	5	700
Lawn mowers	1	150,000
Hatchery facility		
Basins	20	250.00
Buckets	20	250.00
Tank aeration pumps	10	35,000.00
Air stones	50	500.00
Hapa nets (500 m)	1	10,000.00
PVC tanks (Improvised from used PVC tanks) (50 litres each)	50	400.00
Egg trays	50	150.00
Fingerlings scoop nets	4	250.00
Fish fry scoop nets	4	150.00
Thermometers	2	100.00
Dissecting kits	2	500.00
weighing scale	2	10,500.00
Computer/printer	2	150,000
Others	1	200,000
Farm trucks	1	2,500,000

7 ANNEX II: Calculated Investment Statements

All financial values shown in this annex are in Million Kenya Shillings (MKES)

Annex II table 1: Tilapia – Catfish polyculture Investment and Financing

Time period in years		**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Total**
Investment:													
Land		1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	
Ponds		5.83	5.64	5.44	5.25	5.06	4.86	4.67	4.47	4.28	4.08	3.89	
Buildings		7.50	7.35	7.20	7.05	6.90	6.75	6.60	6.45	6.30	6.15	6.00	
Water supply		0.15	0.14	0.14	0.13	0.12	0.11	0.11	0.10	0.09	0.08	0.07	
Equipments and machinery		3.21	2.75	2.29	1.83	1.37	0.92	0.46	0.00	0.00	0.00	0.00	
Booked Value		**18.34**	**17.53**	**16.72**	**15.91**	**15.10**	**14.29**	**13.48**	**12.67**	**12.32**	**11.97**	**11.62**	
Depreciation:													
Ponds	3%		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	**1.94**
Buildings	2%		0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	**1.50**
Water supply	5%		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
Equipments and machinery	14%		0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.00	0.00	0.00	
Total Depreciation			**0.81**	**0.81**	**0.81**	**0.81**	**0.81**	**0.81**	**0.81**	**0.35**	**0.35**	**0.35**	**6.73**
Financing:		**23.70**											
Equity	30%	7.11											
Loans	70%	16.59											
Repayment	9		0.00	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	**16.59**
Principal		16.59	16.59	14.75	12.90	11.06	9.22	7.37	5.53	3.69	1.84	0.00	
Interest	15%		2.49	2.49	2.21	1.94	1.66	1.38	1.11	0.83	0.55	0.28	
Loan Management. Fees	2%	0.33											
Interest+ Management fee		0.33	2.49	2.49	2.21	1.94	1.66	1.38	1.11	0.83	0.55	0.28	**15.26**

Annex II table 2. Tilapia – Catfish polyculture Operations Statement

Time period in years	**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Total**
Sales (Quantity Metric tons)		70.08	70.08	70.08	70.08	70.08	70.08	70.08	70.08	70.08	70.08	**700.80**
Sales Price		0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	
Gross Income		**15.07**	**15.07**	**15.07**	**15.07**	**15.07**	**15.07**	**15.07**	**15.07**	**15.07**	**15.07**	**150.67**
Variable Cost (MKES/Ton)		9.70	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65	**60.51**
Fixed Cost MKES		2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	**29.91**
Total		12.69	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	**90.43**
Operating Surplus (EBITDA)		**2.37**	**6.43**	**6.43**	**6.43**	**6.43**	**6.43**	**6.43**	**6.43**	**6.43**	**6.43**	**60.25**
Inventory Build up		**4.06**										**4.06**
Depreciation	0.00	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.35	0.35	0.35	**6.73**
Operating Gain/Loss	**0.00**	**5.62**	**5.62**	**5.62**	**5.62**	**5.62**	**5.62**	**5.62**	**6.08**	**6.08**	**6.08**	**57.58**
Interest and loan management fee	0.33	2.49	2.49	2.21	1.94	1.66	1.38	1.11	0.83	0.55	0.28	**15.26**
Profit before Tax	**-0.33**	**3.13**	**3.13**	**3.41**	**3.68**	**3.96**	**4.24**	**4.51**	**5.25**	**5.53**	**5.80**	**42.32**
Loss Transfer	-0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**-0.33**
Taxable Profit	0.00	2.80	3.13	3.41	3.68	3.96	4.24	4.51	5.25	5.53	5.80	**42.32**
Income Tax	0.00	0.84	0.94	1.02	1.11	1.19	1.27	1.35	1.57	1.66	1.74	**12.69**
Profit after Tax	**-0.33**	**2.29**	**2.19**	**2.39**	**2.58**	**2.77**	**2.97**	**3.16**	**3.67**	**3.87**	**4.06**	**29.62**
Dividend	0.00	0.23	0.22	0.24	0.26	0.28	0.30	0.32	0.37	0.39	0.41	**3.00**
Net Profit/Loss	**-0.33**	**2.06**	**1.97**	**2.15**	**2.32**	**2.50**	**2.67**	**2.84**	**3.31**	**3.48**	**3.66**	**26.63**
Profit+Depreciation	**-0.33**	**3.10**	**3.00**	**3.20**	**3.39**	**3.58**	**3.78**	**3.97**	**4.03**	**4.22**	**4.41**	
Accumulated Profit+depreciation	**-0.33**	**2.77**	**5.77**	**8.97**	**12.36**	**15.94**	**19.72**	**23.69**	**27.71**	**31.93**	**36.35**	

Annex II table 3: Tilapia – Catfish polyculture Cash Flow

Time period in years	**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Total**
Operating Surplus (EBITDA)	**0.00**	**2.37**	**6.43**	**6.43**	**6.43**	**6.43**	**6.43**	**6.43**	**6.43**	**6.43**	**6.43**	**60.25**
Debtor Changes (acc. Receivable		3.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**3.77**
Creditor Changes (acc payable		1.46	-0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.85**
Cash Flow before Tax	**0.00**	**0.06**	**5.82**	**6.43**	**6.43**	**6.43**	**6.43**	**6.43**	**6.43**	**6.43**	**6.43**	**57.33**
Paid Taxes	0.00	0.00	0.84	0.94	1.02	1.11	1.19	1.27	1.35	1.57	1.66	**10.95**
Cash Flow after Tax	**0.00**	**0.06**	**4.98**	**5.49**	**5.41**	**5.32**	**5.24**	**5.16**	**5.08**	**4.86**	**4.77**	**46.37**
Financial cost	0.33	2.49	2.49	2.21	1.94	1.66	1.38	1.11	0.83	0.55	0.28	**15.26**
Repayment	0.00	0.00	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	**16.59**
Net Cash Flow	**-0.33**	**-2.43**	**0.65**	**1.44**	**1.63**	**1.82**	**2.02**	**2.21**	**2.40**	**2.46**	**2.65**	**14.52**
Paid Dividend		0.00	0.23	0.22	0.24	0.26	0.28	0.30	0.32	0.37	0.39	**2.59**
Financing - Expenditure	5.36											**5.36**
Cash Movement	**5.02**	**-2.43**	**0.42**	**1.22**	**1.39**	**1.56**	**1.74**	**1.91**	**2.09**	**2.09**	**2.27**	**17.29**

Annex II table 4: Tilapia – Catfish polyculture Balance Sheet

	Yr 0	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
Assets											
Cash Account	5.02	2.60	3.02	4.23	5.62	7.19	8.93	10.84	12.93	15.02	17.29
Debtors (Acc receivable)	0.00	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77
Stock	0.00	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06
Current Assets	**5.02**	**10.42**	**10.84**	**12.06**	**13.45**	**15.01**	**16.75**	**18.67**	**20.75**	**22.84**	**25.11**
Fixed Assets	18.34	17.53	16.72	15.91	15.10	14.29	13.48	12.67	12.32	11.97	11.62
Total Assets	**23.37**	**27.95**	**27.57**	**27.97**	**28.55**	**29.31**	**30.24**	**31.34**	**33.07**	**34.81**	**36.73**
Debts											
Dividend Payable	0.00	0.23	0.22	0.24	0.26	0.28	0.30	0.32	0.37	0.39	0.41
Taxes Payable	0.00	0.84	0.94	1.02	1.11	1.19	1.27	1.35	1.57	1.66	1.74
Creditors (Acc payable)	0.00	1.46	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Next Year Repayment	0.00	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	0.00
Current Liabilities	**0.00**	**4.37**	**3.85**	**3.95**	**4.05**	**4.16**	**4.26**	**4.36**	**4.63**	**4.73**	**2.99**
Long Term Loans	16.59	14.75	12.90	11.06	9.22	7.37	5.53	3.69	1.84	0.00	0.00
Total Debt	**16.59**	**19.11**	**16.75**	**15.01**	**13.27**	**11.53**	**9.79**	**8.05**	**6.48**	**4.73**	**2.99**
Equity	7.11	7.11	7.11	7.11	7.11	7.11	7.11	7.11	7.11	7.11	7.11
Profit & Loss Balance	-0.33	1.73	3.70	5.85	8.17	10.67	13.34	16.18	19.49	22.97	26.63
Total Capital	**6.78**	**8.84**	**10.81**	**12.96**	**15.28**	**17.78**	**20.45**	**23.29**	**26.60**	**30.08**	**33.74**
Debts and Capital	**23.37**	**27.95**	**27.57**	**27.97**	**28.55**	**29.31**	**30.24**	**31.34**	**33.07**	**34.81**	**36.73**

Annex II table 5: Tilapia monoculture Investment and Financing

Time period in years		**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Total**
Investment:													
Land		1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	
Ponds		5.83	5.64	5.44	5.25	5.06	4.86	4.67	4.47	4.28	4.08	3.89	
Buildings		7.50	7.35	7.20	7.05	6.90	6.75	6.60	6.45	6.30	6.15	6.00	
Water supply		0.15	0.14	0.14	0.13	0.12	0.11	0.11	0.10	0.09	0.08	0.07	
Equipments and machinery		3.21	2.75	2.29	1.83	1.37	0.92	0.46	0.00	0.00	0.00	0.00	
Booked Value		**18.29**	**17.48**	**16.67**	**15.86**	**15.05**	**14.24**	**13.43**	**12.62**	**12.27**	**11.92**	**11.57**	
Depreciation:													
Ponds	3%		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	**1.94**
Buildings	2%		0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	**1.50**
Water supply	5%		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
Equipments and machinery	14%		0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.00	0.00	0.00	
Total Depreciation			**0.81**	**0.81**	**0.81**	**0.81**	**0.81**	**0.81**	**0.81**	**0.35**	**0.35**	**0.35**	**6.73**
Financing:		**23.04**											
Equity	30%	6.91											
Loans	70%	16.13											
Repayment	9		0.00	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	**16.13**
Principal		16.13	16.13	14.34	12.55	10.75	8.96	7.17	5.38	3.58	1.79	0.00	
Interest	15%		2.42	2.42	2.15	1.88	1.61	1.34	1.08	0.81	0.54	0.27	
Loan management fees	2%	0.32											
Interest+ management fee		0.32	2.42	2.42	2.15	1.88	1.61	1.34	1.08	0.81	0.54	0.27	**14.84**

Annex II table 6: Tilapia monoculture Operations Statement

Time period in years	**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Total**
Sales (Quantity)		60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	**600.00**
Sales Price		0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	
Gross Income		**12.90**	**12.90**	**12.90**	**12.90**	**12.90**	**12.90**	**12.90**	**12.90**	**12.90**	**12.90**	**129.00**
Variable Cost (MKES/Ton)		8.37	4.92	4.92	4.92	4.92	4.92	4.92	4.92	4.92	4.92	**52.64**
Fixed Cost MKES		2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95	**29.46**
Total		11.32	7.86	7.86	7.86	7.86	7.86	7.86	7.86	7.86	7.86	**82.10**
Operating Surplus (EBITDA)		**1.58**	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**	**46.90**
Inventory Build up		**3.45**										**3.45**
Depreciation	0.00	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.35	0.35	0.35	**6.73**
Operating Gain/Loss	**0.00**	**4.23**	**4.23**	**4.23**	**4.23**	**4.23**	**4.23**	**4.23**	**4.68**	**4.68**	**4.68**	**43.63**
Interest and loan management fee	0.32	2.42	2.42	2.15	1.88	1.61	1.34	1.08	0.81	0.54	0.27	**14.84**
Profit before Tax	**-0.32**	**1.81**	**1.81**	**2.07**	**2.34**	**2.61**	**2.88**	**3.15**	**3.88**	**4.15**	**4.41**	**28.79**
Loss Transfer	-0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**-0.32**
Taxable Profit	0.00	1.48	1.81	2.07	2.34	2.61	2.88	3.15	3.88	4.15	4.41	**28.79**
Income Tax	0.00	0.44	0.54	0.62	0.70	0.78	0.86	0.95	1.16	1.24	1.32	**8.64**
Profit after Tax	**-0.32**	**1.36**	**1.26**	**1.45**	**1.64**	**1.83**	**2.02**	**2.21**	**2.71**	**2.90**	**3.09**	**20.15**
Dividend	0.00	0.14	0.13	0.15	0.16	0.18	0.20	0.22	0.27	0.29	0.31	**2.05**
Net Profit/Loss	**-0.32**	**1.22**	**1.14**	**1.31**	**1.48**	**1.65**	**1.82**	**1.98**	**2.44**	**2.61**	**2.78**	**18.10**
Profit+Depreciation	**-0.32**	**2.17**	**2.07**	**2.26**	**2.45**	**2.64**	**2.83**	**3.02**	**3.07**	**3.25**	**3.44**	
Accumulated Profit+Depreciation	**-0.32**	**1.85**	**3.92**	**6.18**	**8.64**	**11.27**	**14.10**	**17.12**	**20.18**	**23.44**	**26.88**	

Annex II table 7: Tilapia monoculture Cash Flow

Time period in years	**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Total**
Operating Surplus (EBITDA)	**0.00**	**1.58**	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**	**46.90**
Debtor Changes (acc. Receivable		3.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**3.23**
Creditor Changes (acc payable		1.26	-0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.74**
Cash Flow before Tax	**0.00**	**-0.39**	**4.52**	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**	**44.42**
Paid Taxes	0.00	0.00	0.44	0.54	0.62	0.70	0.78	0.86	0.95	1.16	1.24	**7.31**
Cash Flow after Tax	**0.00**	**-0.39**	**4.07**	**4.49**	**4.41**	**4.33**	**4.25**	**4.17**	**4.09**	**3.87**	**3.79**	**37.10**
Financial cost	0.32	2.42	2.42	2.15	1.88	1.61	1.34	1.08	0.81	0.54	0.27	**14.84**
Repayment	0.00	0.00	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	**16.13**
Net Cash Flow	**-0.32**	**-2.81**	**-0.14**	**0.55**	**0.74**	**0.93**	**1.12**	**1.30**	**1.49**	**1.54**	**1.73**	**0.61**
Paid Dividend		0.00	0.14	0.13	0.15	0.16	0.18	0.20	0.22	0.27	0.29	**1.74**
Financing - Expenditure	4.75											**4.75**
Cash Movement	**4.43**	**-2.81**	**-0.28**	**0.42**	**0.59**	**0.76**	**0.93**	**1.10**	**1.27**	**1.27**	**1.44**	**9.14**

Annex II table 8: Tilapia monoculture Balance Sheet

Time period in years	**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**
Assets											
Cash Account	4.43	1.62	1.35	1.77	2.36	3.13	4.06	5.16	6.43	7.70	9.14
Debtors (Acc receivable)	0.00	3.23	3.23	3.23	3.23	3.23	3.23	3.23	3.23	3.23	3.23
Stock	0.00	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45
Current Assets	**4.43**	**8.30**	**8.02**	**8.45**	**9.04**	**9.80**	**10.74**	**11.84**	**13.11**	**14.38**	**15.82**
Fixed Assets	18.29	17.48	16.67	15.86	15.05	14.24	13.43	12.62	12.27	11.92	11.57
Total Assets	**22.72**	**25.78**	**24.70**	**24.31**	**24.10**	**24.05**	**24.17**	**24.46**	**25.38**	**26.30**	**27.39**
Debts											
Dividend Payable	0.00	0.14	0.13	0.15	0.16	0.18	0.20	0.22	0.27	0.29	0.31
Taxes Payable	0.00	0.44	0.54	0.62	0.70	0.78	0.86	0.95	1.16	1.24	1.32
Creditors (Acc payable)	0.00	1.26	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Next Year Repayment	0.00	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	0.00
Current Liabilities	**0.00**	**3.63**	**3.20**	**3.30**	**3.40**	**3.50**	**3.60**	**3.70**	**3.96**	**4.06**	**2.37**
Long Term Loans	16.13	14.34	12.55	10.75	8.96	7.17	5.38	3.58	1.79	0.00	0.00
Total Debt	**16.13**	**17.97**	**15.74**	**14.05**	**12.36**	**10.67**	**8.97**	**7.28**	**5.76**	**4.06**	**2.37**
Equity	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91
Profit & Loss Balance	-0.32	0.90	2.04	3.35	4.82	6.47	8.28	10.27	12.71	15.32	18.10
Total Capital	**6.59**	**7.82**	**8.95**	**10.26**	**11.74**	**13.38**	**15.20**	**17.18**	**19.62**	**22.24**	**25.02**
Debts and Capital	**22.72**	**25.78**	**24.70**	**24.31**	**24.10**	**24.05**	**24.17**	**24.46**	**25.38**	**26.30**	**27.39**

Annex II table 9: Bait catfish culture Investment and Financing

Time period in years		**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Total**
Land		0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	
Ponds		3.50	3.38	3.27	3.15	3.03	2.92	2.80	2.68	2.57	2.45	2.33	
Buildings		8.00	7.84	7.68	7.52	7.36	7.20	7.04	6.88	6.72	6.56	6.40	
Water supply		0.15	0.14	0.14	0.13	0.12	0.11	0.11	0.10	0.09	0.08	0.07	
Equipments and machinery		3.72	3.19	2.66	2.13	1.60	1.06	0.53	0.00	0.00	0.00	0.00	
Booked Value		**16.34**	**15.52**	**14.70**	**13.89**	**13.07**	**12.26**	**11.44**	**10.62**	**10.34**	**10.06**	**9.77**	
Depreciation:													
Ponds	3%		0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	**1.17**
Buildings	2%		0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	**1.60**
Water supply	5%		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
Equipments and machinery	14%		0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.00	0.00	0.00	
Total Depreciation			**0.82**	**0.82**	**0.82**	**0.82**	**0.82**	**0.82**	**0.82**	**0.28**	**0.28**	**0.28**	**6.57**
Financing:		**21.09**											
Equity	30%	6.33											
Loans	70%	14.76											
Repayment	9		0.00	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	**14.76**
Principal		14.76	14.76	13.12	11.48	9.84	8.20	6.56	4.92	3.28	1.64	0.00	
Interest	15%		2.21	2.21	1.97	1.72	1.48	1.23	0.98	0.74	0.49	0.25	
Loan management fees	2%	0.30											
Interest+ management fee		0.30	2.21	2.21	1.97	1.72	1.48	1.23	0.98	0.74	0.49	0.25	**13.58**

Annex II table 10: Bait catfish culture Operations Statement

Time period in year	**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Total**
Sales (Quantity)		60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	**600.00**
Sales Price		0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	
Gross Income		**16.00**	**16.00**	**16.00**	**16.00**	**16.00**	**16.00**	**16.00**	**16.00**	**16.00**	**16.00**	**160.00**
Variable Cost (MKES/Ton)		10.12	6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28	**66.63**
Fixed Cost MKES		2.81	2.81	2.81	2.81	2.81	2.81	2.81	2.81	2.81	2.81	**28.09**
Total		12.93	9.09	9.09	9.09	9.09	9.09	9.09	9.09	9.09	9.09	**94.71**
Operating Surplus (EBITDA)		**3.07**	**6.91**	**6.91**	**6.91**	**6.91**	**6.91**	**6.91**	**6.91**	**6.91**	**6.91**	**65.29**
Inventory Build up		**3.84**										**3.84**
Depreciation	0.00	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.28	0.28	0.28	**6.57**
Operating Gain/Loss	**0.00**	**6.10**	**6.10**	**6.10**	**6.10**	**6.10**	**6.10**	**6.10**	**6.63**	**6.63**	**6.63**	**62.56**
Interest and loan management fee	0.30	2.21	2.21	1.97	1.72	1.48	1.23	0.98	0.74	0.49	0.25	**13.58**
Profit before Tax	**-0.30**	**3.88**	**3.88**	**4.13**	**4.37**	**4.62**	**4.87**	**5.11**	**5.89**	**6.14**	**6.38**	**48.98**
Loss Transfer	-0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**-0.30**
Taxable Profit	0.00	3.59	3.88	4.13	4.37	4.62	4.87	5.11	5.89	6.14	6.38	**48.98**
Income Tax	0.00	1.08	1.16	1.24	1.31	1.39	1.46	1.53	1.77	1.84	1.91	**14.69**
Profit after Tax	**-0.30**	**2.81**	**2.72**	**2.89**	**3.06**	**3.23**	**3.41**	**3.58**	**4.12**	**4.30**	**4.47**	**34.29**
Dividend	0.00	0.28	0.27	0.29	0.31	0.32	0.34	0.36	0.41	0.43	0.45	**3.46**
Net Profit/Loss	**-0.30**	**2.53**	**2.45**	**2.60**	**2.76**	**2.91**	**3.07**	**3.22**	**3.71**	**3.87**	**4.02**	**30.83**
Profit+Depreciation	**-0.30**	**3.62**	**3.53**	**3.71**	**3.88**	**4.05**	**4.22**	**4.39**	**4.41**	**4.58**	**4.75**	
Accumulated Profit+Depreciation	**-0.30**	**3.33**	**6.86**	**10.57**	**14.45**	**18.50**	**22.72**	**27.11**	**31.52**	**36.10**	**40.85**	

Annex II table 11: Bait catfish culture Cash Flow

Time Period In Years	**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Total**
Operating Surplus (EBITDA)	**0.00**	**3.07**	**6.91**	**6.91**	**6.91**	**6.91**	**6.91**	**6.91**	**6.91**	**6.91**	**6.91**	**65.29**
Debtor Changes (acc. Receivable		4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**4.00**
Creditor Changes (acc payable		1.52	-0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.94**
Cash Flow before Tax	**0.00**	**0.59**	**6.34**	**6.91**	**6.91**	**6.91**	**6.91**	**6.91**	**6.91**	**6.91**	**6.91**	**62.23**
Paid Taxes	0.00	0.00	1.08	1.16	1.24	1.31	1.39	1.46	1.53	1.77	1.84	**12.78**
Cash Flow after Tax	**0.00**	**0.59**	**5.26**	**5.75**	**5.67**	**5.60**	**5.53**	**5.45**	**5.38**	**5.15**	**5.07**	**49.45**
Financial cost	0.30	2.21	2.21	1.97	1.72	1.48	1.23	0.98	0.74	0.49	0.25	**13.58**
Repayment	0.00	0.00	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	**14.76**
Net Cash Flow	**-0.30**	**-1.62**	**1.41**	**2.14**	**2.31**	**2.48**	**2.66**	**2.83**	**3.00**	**3.01**	**3.19**	**21.11**
Paid Dividend		0.00	0.28	0.27	0.29	0.31	0.32	0.34	0.36	0.41	0.43	**3.01**
Financing - Expenditure	4.75											**4.75**
Cash Movement	**4.45**	**-1.62**	**1.13**	**1.87**	**2.02**	**2.18**	**2.33**	**2.49**	**2.64**	**2.60**	**2.76**	**22.85**

Annex II table 12: Bait catfish culture Balance Sheet

Time period in years		**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**
Assets												
Cash Account	0	4.45	2.83	3.96	5.82	7.85	10.03	12.36	14.85	17.49	20.09	22.85
Debtors (Acc receivable)	25%	0.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Stock	0	0.00	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84
Current Assets		**4.45**	**10.67**	**11.80**	**13.66**	**15.69**	**17.87**	**20.20**	**22.69**	**25.33**	**27.93**	**30.69**
Fixed Assets		16.34	15.52	14.70	13.89	13.07	12.26	11.44	10.62	10.34	10.06	9.77
Total Assets		**20.79**	**26.19**	**26.50**	**27.55**	**28.76**	**30.12**	**31.64**	**33.31**	**35.67**	**37.99**	**40.46**
Debts												
Dividend Payable		0.00	0.28	0.27	0.29	0.31	0.32	0.34	0.36	0.41	0.43	0.45
Taxes Payable		0.00	1.08	1.16	1.24	1.31	1.39	1.46	1.53	1.77	1.84	1.91
Creditors (Acc payable)	15%	0.00	1.52	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Next Year Repayment		0.00	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	0.00
Current Liabilities		**0.00**	**4.51**	**4.02**	**4.11**	**4.20**	**4.29**	**4.38**	**4.47**	**4.76**	**4.85**	**3.30**
Long Term Loans		14.76	13.12	11.48	9.84	8.20	6.56	4.92	3.28	1.64	0.00	0.00
Total Debt		**14.76**	**17.63**	**15.50**	**13.95**	**12.40**	**10.85**	**9.30**	**7.75**	**6.40**	**4.85**	**3.30**
Equity		6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33
Profit & Loss Balance		-0.30	2.23	4.68	7.28	10.03	12.94	16.01	19.23	22.94	26.81	30.83
Total Capital		**6.03**	**8.56**	**11.00**	**13.60**	**16.36**	**19.27**	**22.34**	**25.56**	**29.27**	**33.13**	**37.15**
Debts and Capital		**20.79**	**26.19**	**26.50**	**27.55**	**28.76**	**30.12**	**31.64**	**33.31**	**35.67**	**37.99**	**40.46**

Annex II table 13: Trout Culture Investment and Financing

Time period in years		**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Total**
Investment:													
Land		0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	
Ponds		2.25	2.18	2.10	2.03	1.95	1.88	1.80	1.73	1.65	1.58	1.50	
Buildings		7.50	7.35	7.20	7.05	6.90	6.75	6.60	6.45	6.30	6.15	6.00	
Water supply		0.15	0.14	0.14	0.13	0.12	0.11	0.11	0.10	0.09	0.08	0.07	
Equipments and machinery		3.20	2.75	2.29	1.83	1.37	0.92	0.46	0.00	0.00	0.00	0.00	
Booked Value		**13.42**	**12.73**	**12.04**	**11.35**	**10.66**	**9.97**	**9.28**	**8.59**	**8.36**	**8.12**	**7.89**	
Depreciation:													
Ponds	3%		0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	**0.75**
Buildings	2%		0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	**1.50**
Water supply	5%		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
Equipments and machinery	14%		0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.00	0.00	0.00	
Total Depreciation			**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.23**	**0.23**	**0.23**	**5.53**
Financing:		**33.42**											
Equity	30%	10.03											
Loans	70%	23.39											
Repayment period (years)	9		0.00	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	**23.39**
Principal		23.39	23.39	20.79	18.19	15.60	13.00	10.40	7.80	5.20	2.60	0.00	
Interest	15%		3.51	3.51	3.12	2.73	2.34	1.95	1.56	1.17	0.78	0.39	
Loan management fees	2%	0.47											
Interest+ Management fee		0.47	3.51	3.51	3.12	2.73	2.34	1.95	1.56	1.17	0.78	0.39	**21.52**

Annex II table 14: Trout Culture Operations Statement

Time period in years	**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Total**
Sales (Quantity Tons)			60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	**540.00**
Sales Price		0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	
Gross Income		**0.00**	**24.00**	**24.00**	**24.00**	**24.00**	**24.00**	**24.00**	**24.00**	**24.00**	**24.00**	**216.00**
Variable Cost (MKES/Ton)		12.15	9.15	9.15	9.15	9.15	9.15	9.15	9.15	9.15	9.15	**94.52**
Fixed Cost MKES		3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	**37.47**
Total		15.90	12.90	12.90	12.90	12.90	12.90	12.90	12.90	12.90	12.90	**131.99**
Operating Surplus (EBITDA)		**-15.90**	**11.10**	**11.10**	**11.10**	**11.10**	**11.10**	**11.10**	**11.10**	**11.10**	**11.10**	**84.01**
Inventory Build up		**3.00**										**3.00**
Depreciation	0.00	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.23	0.23	0.23	**5.53**
Operating Gain/Loss	**0.00**	**-13.59**	**10.41**	**10.41**	**10.41**	**10.41**	**10.41**	**10.41**	**10.87**	**10.87**	**10.87**	**81.48**
Interest and loan management fee	0.47	3.51	3.51	3.12	2.73	2.34	1.95	1.56	1.17	0.78	0.39	**21.52**
Profit before Tax	**-0.47**	**-17.10**	**6.90**	**7.29**	**7.68**	**8.07**	**8.46**	**8.85**	**9.70**	**10.09**	**10.48**	**59.96**
Loss Transfer	-0.47	-17.57	-10.66	-3.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**-32.07**
Taxable Profit	0.00	0.00	0.00	0.00	4.31	8.07	8.46	8.85	9.70	10.09	10.48	**59.96**
Income Tax	0.00	0.00	0.00	0.00	1.29	2.42	2.54	2.66	2.91	3.03	3.14	**17.99**
Profit after Tax	**-0.47**	**-17.10**	**6.90**	**7.29**	**6.39**	**5.65**	**5.92**	**6.20**	**6.79**	**7.06**	**7.34**	**41.97**
Dividend	0.00	0.00	0.69	0.73	0.64	0.57	0.59	0.62	0.68	0.71	0.73	**5.95**
Net Profit/Loss	**-0.47**	**-17.10**	**6.21**	**6.56**	**5.75**	**5.09**	**5.33**	**5.58**	**6.11**	**6.36**	**6.60**	**36.02**
Profit+Depreciation	**-0.47**	**-16.41**	**7.59**	**7.98**	**7.08**	**6.34**	**6.61**	**6.89**	**7.02**	**7.29**	**7.57**	
Accumulated Profit+Depreciation	**-0.47**	**-16.88**	**-9.28**	**-1.30**	**5.78**	**12.12**	**18.73**	**25.62**	**32.64**	**39.93**	**47.50**	

Annex II table 15: Trout Culture Cash Flow

Time period in years	**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Total**
Operating Surplus (EBITDA)	**0.00**	**-15.90**	**11.10**	**11.10**	**11.10**	**11.10**	**11.10**	**11.10**	**11.10**	**11.10**	**11.10**	**84.01**
Debtor Changes (acc. Receivable)		0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**6.00**
Creditor Changes (acc payable)		1.82	-0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.37**
Cash Flow before Tax	**0.00**	**-14.08**	**4.65**	**11.10**	**11.10**	**11.10**	**11.10**	**11.10**	**11.10**	**11.10**	**11.10**	**79.38**
Paid Taxes	0.00	0.00	0.00	0.00	0.00	1.29	2.42	2.54	2.66	2.91	3.03	**14.84**
Cash Flow after Tax	**0.00**	**-14.08**	**4.65**	**11.10**	**11.10**	**9.81**	**8.68**	**8.56**	**8.45**	**8.19**	**8.07**	**64.54**
Financial cost	0.47	3.51	3.51	3.12	2.73	2.34	1.95	1.56	1.17	0.78	0.39	**21.52**
Repayment	0.00	0.00	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	**23.39**
Net Cash Flow	**-0.47**	**-17.59**	**-1.46**	**5.38**	**5.77**	**4.87**	**4.13**	**4.40**	**4.68**	**4.81**	**5.09**	**19.62**
Paid Dividend		0.00	0.00	0.69	0.73	0.64	0.57	0.59	0.62	0.68	0.71	**5.22**
Financing - Expenditure	20.00											**20.00**
Cash Movement	**19.53**	**-17.59**	**-1.46**	**4.69**	**5.04**	**4.23**	**3.57**	**3.81**	**4.06**	**4.13**	**4.38**	**34.40**
Accumulated Net cash Flow	**-0.47**	**-18.05**	**-19.51**	**-14.13**	**-8.36**	**-3.49**	**0.65**	**5.05**	**9.73**	**14.54**	**19.62**	

Annex II table 16: Trout Culture Balance Sheet

Balance Sheet	**Yr 0**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**
Assets											
Cash Account	19.53	1.95	0.49	5.18	10.23	14.46	18.02	21.83	25.89	30.02	34.40
Debtors (Acc receivable)	0.00	0.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Stock	0.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Current Assets	**19.53**	**4.95**	**9.49**	**14.18**	**19.23**	**23.46**	**27.02**	**30.83**	**34.89**	**39.02**	**43.40**
Fixed Assets	13.42	12.73	12.04	11.35	10.66	9.97	9.28	8.59	8.36	8.12	7.89
Total Assets	**32.95**	**17.68**	**21.53**	**25.53**	**29.88**	**33.42**	**36.30**	**39.42**	**43.25**	**47.15**	**51.29**
Debts											
Dividend Payable	0.00	0.00	0.69	0.73	0.64	0.57	0.59	0.62	0.68	0.71	0.73
Taxes Payable	0.00	0.00	0.00	0.00	1.29	2.42	2.54	2.66	2.91	3.03	3.14
Creditors (Acc payable)	0.00	1.82	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37
Next Year Repayment	0.00	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	0.00
Current Liabilities	**0.00**	**4.42**	**4.66**	**4.70**	**5.90**	**6.96**	**7.10**	**7.25**	**7.56**	**7.70**	**5.25**
Long Term Loans	23.39	20.79	18.19	15.60	13.00	10.40	7.80	5.20	2.60	0.00	0.00
Total Debt	**23.39**	**25.22**	**22.86**	**20.30**	**18.90**	**17.36**	**14.90**	**12.45**	**10.16**	**7.70**	**5.25**
Equity	10.03	10.03	10.03	10.03	10.03	10.03	10.03	10.03	10.03	10.03	10.03
Profit & Loss Balance	-0.47	-17.57	-11.35	-4.79	0.96	6.04	11.37	16.95	23.06	29.42	36.02
Total Capital	**9.56**	**-7.54**	**-1.33**	**5.23**	**10.98**	**16.07**	**21.40**	**26.98**	**33.09**	**39.44**	**46.04**
Debts and Capital	**32.95**	**17.68**	**21.53**	**25.53**	**29.88**	**33.42**	**36.30**	**39.42**	**43.25**	**47.15**	**51.29**