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PROFITABILITY ASSESSMENT: A CASE STUDY OF AFRICAN CATFISH *(CLARIAS GARIEPINUS)* FARMING IN THE LAKE VICTORIA BASIN, KENYA

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ABSTRACT

This paper presents a profitability assessment tool developed for the purposes of evaluating the feasibility of fish farming investment and operations. As a test case, small scale African catfish (*Clarias gariepinus*) farming in the Lake Victoria basin, Kenya is used. The analysis formulated assumptions based on secondary data on catfish production. The data was collected by reviewing both printed and electronic articles from research publications in the library. Other information was derived from the personal experience of the author in catfish research. A budgetary unit of a 1-ha (12 ponds) catfish farm was used. To evaluate the profitability of the venture, indicators of investment returns were determined such as net present value (NPV) and internal rate of return (IRR), payback period and debt service coverage ratio. A sensitivity analysis on stocking density, survival rates, cost of feed, cost of fingerlings and sales price was also conducted. The findings of the analysis indicate that catfish farming is financially feasible. The results obtained indicate a positive NPV and acceptable IRR and a pay back period of five years. A debt service coverage ratio of more than 1.5 was obtained thus indicating that the cash flow is adequate. Sensitivity analysis on price, sales and investment obtained indicate that the enterprise is highly sensitive to stocking density, survival rates and sales price but less sensitive to costs of fingerlings and costs of feed used in the production. It is also more economical to operate 12 ponds than one pond due to gains from economies of scale.

Key words: *Profitability analysis, African catfish (Clarias gariepinus), Lake Victoria basin, Kenya, small-scale fish farming, monoculture.*

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1 INTRODUCTION

1.1 Background

The increase in human population and reports of large numbers of undernourished or starving people, especially in the developing countries, have made the need for food production a major worldwide issue of concern. There are three main groups of activities that contribute to food production: agriculture, aquaculture and fisheries. Recent knowledge shows that the world's natural stocks of fish and shell fish, though renewable, have finite production limits, which cannot be exceeded even under the best management regimes. For most of our lakes, rivers and oceans, the maximum sustainable fishing limit has been exceeded (FAO 2000e). Therefore, fish production will depend on aquaculture to bridge the gap of fish supply (Tacon 2001).

In Kenya, Lake Victoria is a major source of quality protein food in the form of fish of various species. The Lake Victoria fishery provides employment and income to communities living in the Lake region and other parts of the country. It is also a major source of foreign exchange through exports of fish, mainly Nile perch fillets (Abila 2003).

The Lake Victoria fishery has over the last two decades shifted from a complex multi-species fishery to one dominated by only three fish species, namely Nile perch, Nile tilapia and *Rastrineobola argentea* ("dagaa"). Over the last three to five years, there has been evidence of decline in catch per unit effort and the average sizes of fish caught. At the same time, the fishing effort (in terms of fishers, fishing gear, and crafts) has been rising steadily (Othina *et al.* 2003). Environmental threats also pose a great danger to fish production from the lake.

As the scenario calls for prudent management of the fish stocks in the lake, there is need to augment fish production in the country through aquaculture. Aquaculture has never really taken off in the country and lack of information on profitability of fish farming could be one reason among other constraints. The profitability of aquaculture as a business has not been demonstrated as compared to other industries in the country like agriculture and horticulture. Tilapia is the main farmed species. Commercial production of this species has been hampered by small harvests resulting from excessive reproduction and stunting. Hence there is need for alternative culture approaches (Lovshin *et al.* 1990). One idea would be to grow a ferocious feeder and fast growing fish, a description that correctly fits the African catfish (*Clarias gariepinus*).

1.2 Goal/Vision

The goal of this study is to develop a decision support tool for profitability assessment of fish farming. As a case example, catfish farming in the Lake Victoria basin in Kenya is studied. The vision is that this may, in the future, be of valuable help to evaluate the profitability and thus the sustainability of fish farming in the country. Kenya needs to make aquaculture a profitable and competitive industry like agriculture and horticulture, preferably within the next 10 years (GoK 2003). To help the farmers to understand the management, economic and business aspects of fish farming, a pamphlet with such information is proposed, as well as a guide to record keeping and data collection.

1.3 Main tasks

The overall breakdown of the project is as follows:

1) Collect and analyse data on catfish farming operations in the Lake Victoria basin in order to estimate model parameters.
2) Develop a production planning model in Microsoft Excel, which will serve to plan the operations of catfish farming in the Lake Victoria basin.
3) Develop a profitability model and an aquaculture business plan for catfish farming in the Lake Victoria basin.
4) Perform sensitivity analysis with respect to uncertainties.
5) Write a pamphlet for fish farmers on catfish farming as a business.
6) Prepare a technical document on catfish farming record keeping for data collection.

2 JUSTIFICATION AND BENEFITS

2.1 Justification

Most fish farmers in Kenya lack information on how to asses the profitability of their farms (Omondi *et al.* 2001). This has partly hampered aquaculture development in the country leading to 'potential' farmers avoiding going into fish farming and others becoming 'inactive' because aquaculture profitability has not been demonstrated to them. Financing institutions and banks are not keen to lend money to farmers whose enterprises cannot be feasibly appraised.

At present, aquaculture in Kenya is characteristically done for domestic consumption, adopting low investment and in return getting low pond production. The ponds are small in size with a production output hardly exceeding 0.15 kg/m^2 $year^{-1}$. Most of these ponds are for extensive fish production. There are also a few semi-intensive systems producing 0.5 – 1.5 kg/ m^2 $year^{-1}$. Intensive systems of production are even fewer, the most notable example being the Baobab farm, which can produce 5 – 45 kg m^2 $year^{-1}$ (Abila 2003). Mbugua describes fish-farming systems in Kenya as being relatively underdeveloped, mainly using earthen ponds. Fish farming is practiced at varying degrees of intensification using the following holding units (Mbugua 2002):

(i) Pond culture: Mainly use earthen ponds for extensive or semi-intensive aquaculture. Mostly for the culture of tilapines, catfish and common carp.
(ii) Raceway culture: These are rectangular ponds through which water flows continuously. They are either concrete or earthen, although the latter is more common in Kenya. These units allow for high stocking densities because of the high water exchange rate and provision of a complete diet for the fish. Raceway culture is used in most trout farms. Examples include Kiganjo Trout Hatchery, Ndaragwa Trout Farm and Baobab Fish Farm.
(iii) Tank culture: Tanks are usually circular concrete structures with a central outlet. This system deploys continuous water flow and complete feeding with formulated feeds.

There is considerable interest in the development of fish farming in Kenya. Further growth and development of the aquaculture industry in the country will depend upon its profitability. Estimates of net returns are essential for both the prospective producer and the financing institutions to evaluate the risk and potential profitability in comparison to alternative enterprises (Tisdell 2003).

The aim of this study is to evaluate the profitability of small scale catfish farming in the Lake Victoria basin of Kenya targeting the local market. Presently catfish farming activity is not run as a business in comparison with other agriculture or livestock based industries in the country. If catfish farming can be demonstrated to be profitable at the small scale level, entrepreneurs may take it up at the commercial level and produce for large scale markets and export.

2.2 Anticipated benefits

A production planning model, a profitability model, an information pamphlet and a record keeping guide for small scale catfish farming will be developed. The products of the study will be used as guides for prospective and existing fish farmers in Kenya. The information generated will provide farmers with appropriate tools to determine profitability of their farms and also help lending institutions to better assess the viability of aquaculture projects and reduce the rate of failure in loan repayment.

It is expected that profitable small scale fish farms will, in the future, increasingly supply the local market with fish. This will improve the per capita fish consumption in the country, which is presently 6 kg person^{-1} yr^{-1}, far below the world average per capita consumption of 16 kg person^{-1} yr^{-1} (World Resource Institute 2003). The productions from aquaculture will augment catches from capture fisheries. Further, it is anticipated that a successful and vibrant small scale aquaculture industry could trigger a commercial aquaculture industry in the country. In addition, the small scale farmers might grow in capital and knowledge and transform themselves into medium and eventually large scale farmers.

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

3 KENYAN AQUACULTURE

3.1 The Lake Victoria basin of Kenya

The Lake Victoria basin of Kenya (Figure 1) is a major source of fish and fisheries products both from capture fisheries and aquaculture. It covers an area of over 38,913 km^2 (East African Community 2004). Over 93% of the country's total fish production comes from the Kenya waters of Lake Victoria and its basin. The annual average total production of fish in the country is estimated at 180,000 metric tons (mt) valued at 6.7 million Kenya shillings (Ksh) to the fishermen with a retail value of Ksh 25 billion (Wakwabi *et al.* 2003). The commercially important fish species of Lake Victoria are *Lates niloticus* (Nile perch), *Rastrineobola argentea* (dagaa) and *Oreochromis* species (tilapia). These species account for 58%, 30% and 10%

respectively of the total weight of fish landed. Besides Lake Victoria, the other sources of fish in the country are the fresh-water lakes, dams and rivers located in various parts of the country, most of which drain into Lake Victoria (Abila 2003). Aquaculture accounts for less than 1% of the total production (Figure 2), with tilapia, trout and catfish being the main farmed fish species.

The region has a population of over 9 million people and is one of the most densely populated parts of Kenya. The area has a high altitude averaging 1,157 m above sea level, has an annual rainfall of 1,000 – 13,000 mm, a temperature range of 14 - 34ºC and a long rainy season. Its largely red soils are very productive and extensively cultivated. It is a multi-river basin containing eight major rivers namely, the Mara, Kuja, Migori, Sondu-Miriu, Nyando, Yala, Nzoia and Sio, all of which enhance the potential for the development of aquaculture. Besides the major river systems, there are numerous smaller river systems and man-made dams. The basin is warm enough to permit year round production of warm water fish (Okemwa and Getabu 1996).

Natural resources are the ecological boon to the development of rural communities. Various water resources – large, medium and small bodies of water are available for community fish culture in the villages of the Lake Victoria basin, but most of them are underutilized or unutilized. Some unconventional water areas such as canals or roadside ditches also have the potential for intensive aquaculture.

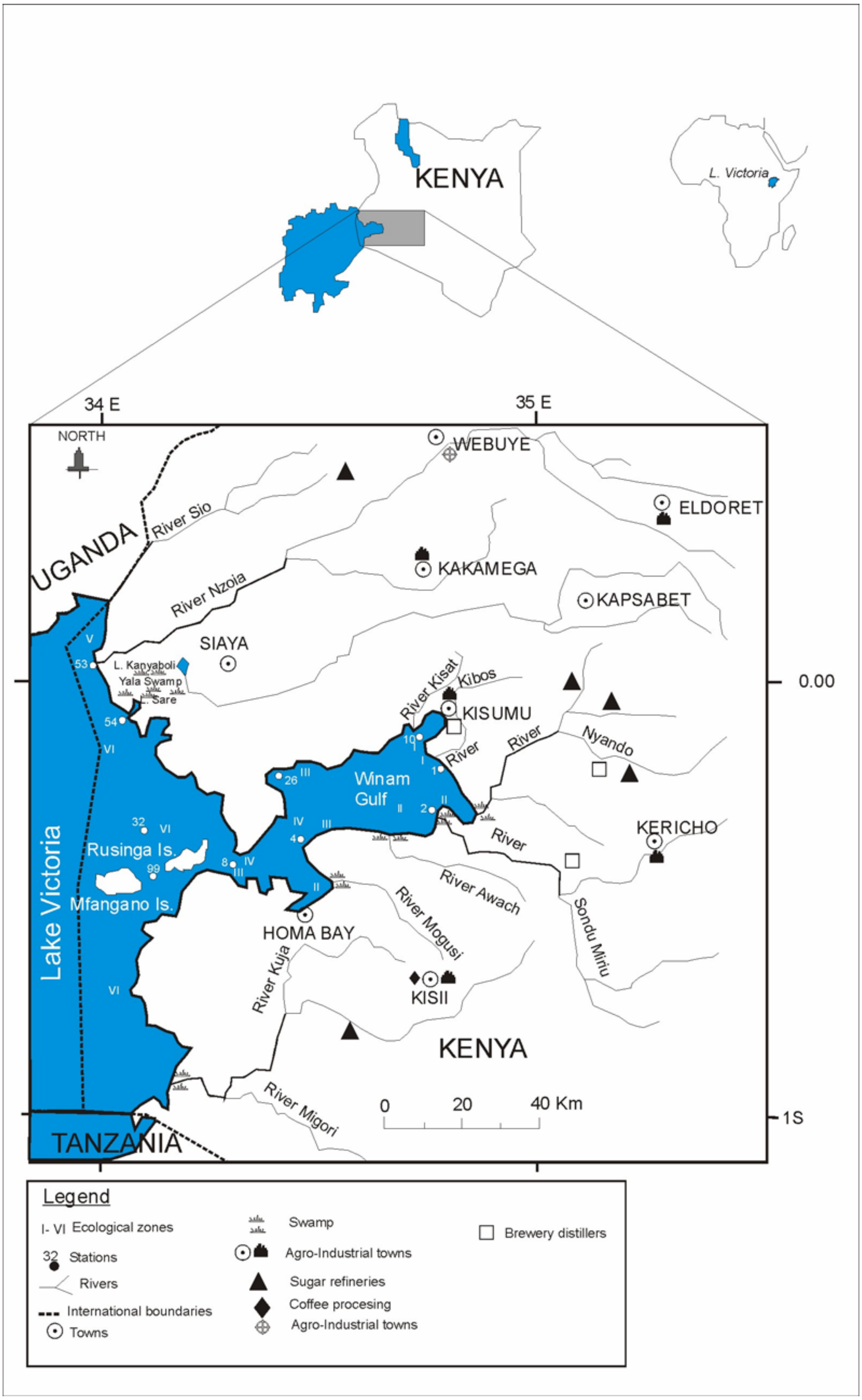

Figure 1: Map of the Lake Victoria basin, Kenya, showing drainage patterns (Gichuki 2003).

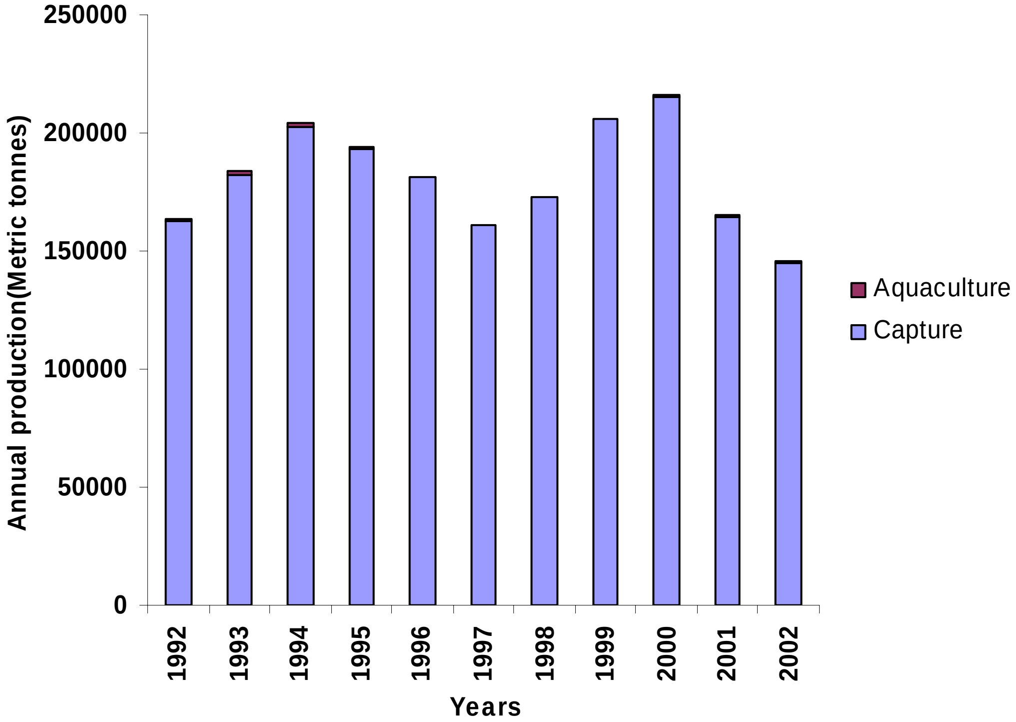

Figure 2: Aquaculture contribution to total fish production in Kenya (adapted from FAO 2002).

3.2 Threats to capture fisheries

The Food and Agriculture Organization of the United Nations, in concurrence with fisheries experts from around the world, has concluded that virtually all the fisheries resources utilized for human consumption in the world (not just in Kenya) are being exploited at their Maximum Sustainable Level (MSL) and many actually are exceeding that value (FAO 2000e). Apart from over-fishing, factors such as pollution and invasive weeds (e.g. water hyacinth) have led to environmental degradation resulting in a decline of catches from Lake Victoria. Indiscriminate agricultural practices in the catchments also threaten the lake and other water bodies with problems including pollution, nutrient loading and siltation. As capture fisheries continue to decline due to over-fishing, wetland reclamation for agriculture and environmental pollution, aquaculture is increasingly being considered the only alternative to development and improvement of fisheries resources and revitalization of the ecosystems (Leroy 1999).

3.3 History of fish farming in Kenya

In Kenya fish farming dates back to the early 20th century when trout was introduced as sport fish for stocking rivers between 1910 and 1921 (Okemwa and Getabu 1996). The rearing of the African cichlids has been done in ponds since 1924 with some experiments in tilapia rearing. It is thought that proper fish farming started in around 1948 nationwide (Balarin 1985). The establishment of Sagana and Kiganjo fish culture stations in 1948 sparked an interest in rural fishponds. The “eat more fish campaign" by the Fisheries Department led to the rapid spread of rural fish ponds to other parts of the country where fish farming could be practiced. This led to extensive construction of fishponds particularly in the Lake Victoria basin of Kenya. It is estimated that the Nyanza and Western provinces alone had over 30,000 fishponds (Zonneveld 1983). Most of the fishponds were small and many were abandoned (Kagai 1975). This led to a reduction in the number of fish ponds in the region largely due to poor yields, lack of fingerlings and lack of technical expertise on fish farming in general. The production from aquaculture has remained relatively low or about 1000 mt $year^{-1}$ (Figure 3). The annual production figures for the last two years (2001 and 2002) were obtained from FAO 2002a.

The species largely utilized for pond culture are *Oreochromis niloticus* and the African catfish *(Clarias gariepinus)*. Culture of other exotic fish species for aquaculture includes the largemouth bass *(Micropterus salmoides),* trout *(Salmo trutta* and *Salmo gairdneri*) for river and lake stocking and *Oreochromis spirulus niger* (Balarin 1985). In the past, a number of development agencies have aided projects on aquaculture research and development in the country. A most notable recent example is the World Bank Programme, through the Lake Victoria Environment Management Project (World Bank 1996).

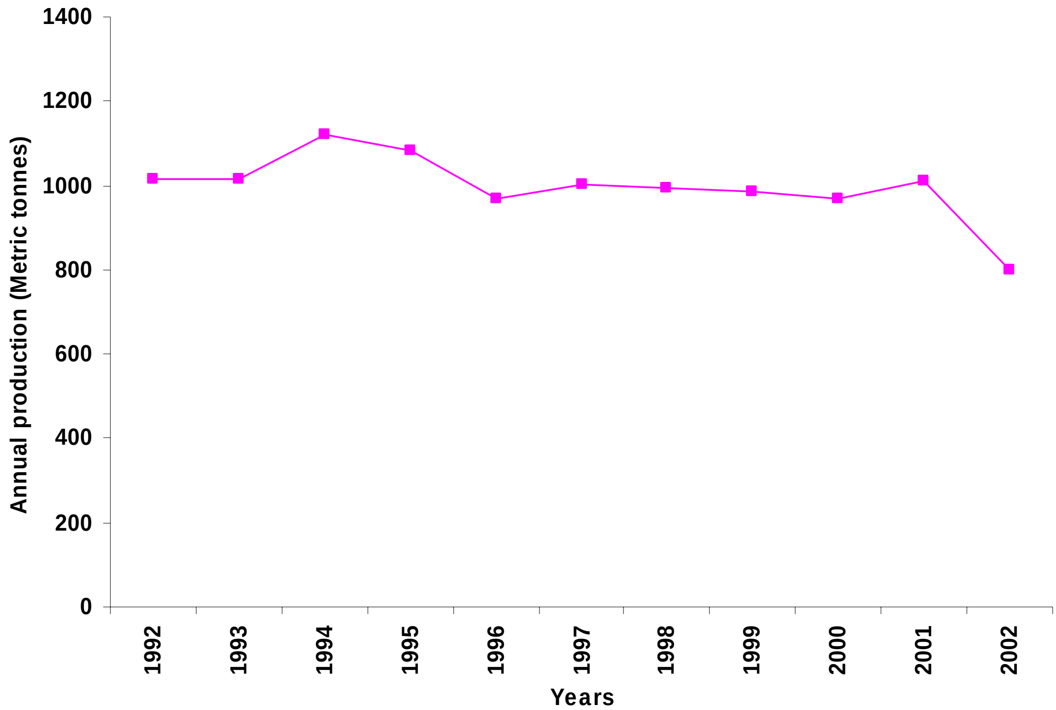

Figure 3: Aquaculture production in Kenya 1992-2000 (Modified from Abila 2003 and FAO 2002b)

3.4 Demands for fish and fish products

Whereas aquaculture has been the fastest growing food-producing sector globally, its contribution to Kenya's total fish production is still insignificant (Machena and Moehl 2001 and Figures 2 & 3). Dismal aquaculture production coupled with declining catches of indigenous fish species has increased the gap between supply and demand of fish among riparian communities in Kenya. Unlike the indigenous fish species that were easily harvested by the local fishers, the fishery of the alien Nile perch that dominates the lake's catch require some expensive gear and craft for harvesting this large species (which many poor people cannot afford). Much of the Nile perch catches go to the processing factories. As a result many people who cannot afford *L.niloticus* fillets have recently resorted to feeding on the remaining axial skeleton "Mgongo wazi" after the filleting process. Therefore, the supply of fish and fishery products in this region is declining compared to the demand (Abila 2003). For food security and improved nutrition there is a need to develop a sustainable aquaculture industry in the riparian communities through production of high quality, indigenous fish. This will also supplement capture fisheries.

3.5 Culture of African catfish (*Clarias gariepinus*) in Kenya

Catfish (Figure 4) is an endemic species having a ubiquitous distribution in rivers, streams, dams and lakes in the country. All the *Clarias* species reported in Kenya (Greenwood 1966 and Teugels 1986) inhabit wetlands or wetland open interface. These groups of fish (siluriformes) are widely consumed in East Africa. Successful culture/captive breeding of this species has been done in the country and fingerlings raised (Campell *et al.* 1995, Campell 1995 and Macharia *et al.* 2002).

Figure 4: African catfish *(Clarias gariepinus)*. Photo by Dr.J. Rutaisire 2005.

In the culture of this species artificial reproduction ensures a year-round supply of fish seed. The African catfish is relatively insensitive to disease and does not have high water quality requirements. It tolerates high concentrations in the water of ammonia (NH_3) and nitrite (NO_2). Low oxygen concentrations are tolerated because the fish utilizes atmospheric as well as dissolved oxygen, (well developed air breathing organs). It grows fast and feeds on a large variety of agriculture by products (De

Graaf and Janssen 1996). It can be raised in high densities resulting in high yields (6–16 tons ha^{-1} $year^{-1}$); and fetches a higher price than tilapia as it can be sold live at the market. The optimum temperature for growth is 25^0C (Hogendoorn 1979).

The Lake Basin Development Authority (LBDA) started to produce and raise catfish in 1993 with the intention of supplying farmers with fingerlings. The authority has six fry production centres (FPC) in the basin at Kibos, Yala, Alupe, Chwele, Borabu and Rongo. Individual farmers also produce fingerlings in their farms with technical assistance from research institutions and extensions services. Catfish fingerlings weighing 10 g are sold for stocking at an average price of Ksh 5/individual (from personal experience). It can be observed from the production trends that there has been a steady increase in production of farmed catfish since 1998 (Figure 5). However, there is a discrepancy in the total annual aquaculture production (Figure 3) and that reported by FAO over the same period (Figure 5). This discrepancy should be addressed in the future so as to have a harmonised way in data reporting.

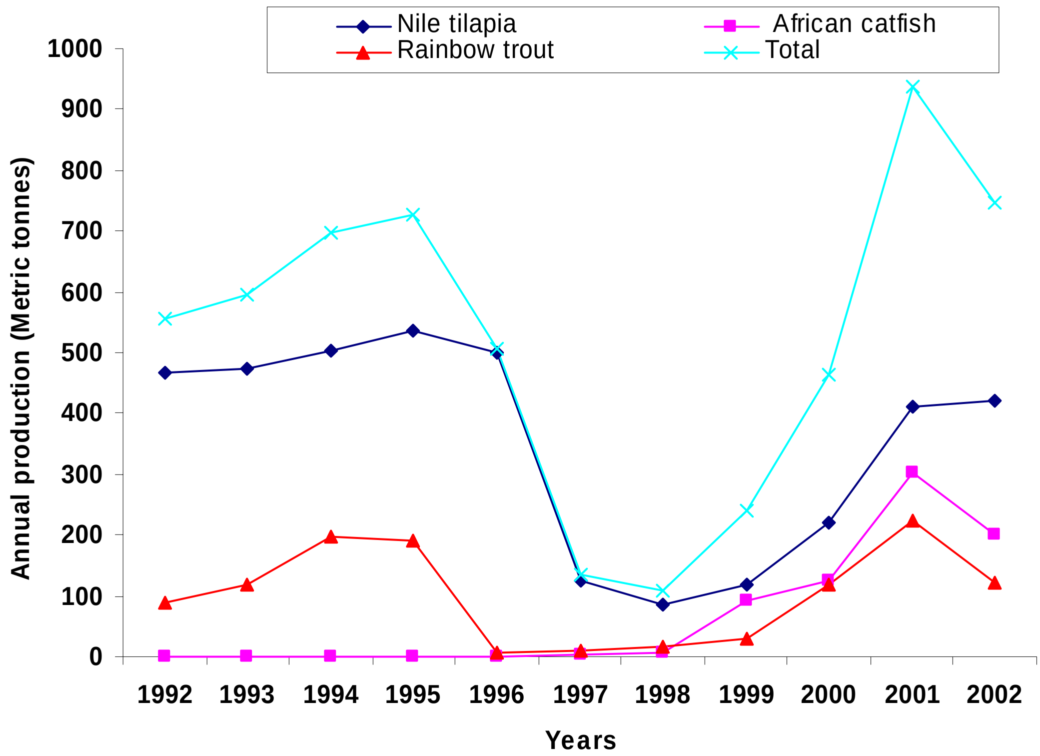

Figure 5: Aquaculture production in Kenya by species (adapted from FAO 2002b).

Feeding of catfish is mainly by fertilizing the ponds and the use of agricultural by-products in the farms. Supplementary feeding is done with feed prepared from locally available farm by products such as rice bran, wheat bran and fish meal. The feed should contain 30–35% digestible protein (about 40–50% crude protein) and 2500–3500 kcal digestible energy kg^{-1} feed and about 3500–4500 crude energy kg^{-1} feed (De Graaf and Janseen 1996, Janssen 1987).

The demand for catfish fingerlings as bait fish for the Nile perch fishery in Lake Victoria has attracted a lot of interest from fish farmers. In addition to the local demand, presently there is huge demand for catfish fingerlings (both for stocking and bait fish) in the neighbouring countries (Uganda and Tanzania). Therefore, in addition to producing for the local market, farmers can also target the regional market.

3.6 Economic analysis of aquaculture in Kenya

Aquaculture development at the global level has been viewed as a measure of improving food security and as a means of supplementing income for rural families. In many countries, particularly in Africa, aquaculture is almost entirely for subsistence, with little surplus production being sold in the rural market. In this continent, economic analysis in aquaculture is a relatively recent practice and not much work has been reported on its social and economic impacts (Egna and Boyd 1997).

Economic considerations in the selection of an appropriate aquaculture production system include its potential for economic returns, its economic efficiency and, ultimately, the farmer's access to operating capital (Hebicha *et al.* 1994). There are no reports on the economic evaluation of aquaculture production systems in Kenya, other than the few case studies on tilapia production (Omondi *et al.* 2001 and Veverica *et al.* 2001)

It is against this background that the present study was undertaken to assess the profitability of fish farming in Kenya using catfish as a case study and to provide farmers and investors with a tool to use in determining the feasibility of aquaculture enterprises and monitoring their performances.

4 METHODOLOGY

4.1 Data collection and main assumptions

This work involved the search and collection of secondary data and information on specific aspects of catfish farming and production in the Lake Victoria basin, Kenya. The information was collected by reviewing both print and electronic documents from research publications (library and on-line reprints and databases). Other information was also derived from the personal experience of the author in catfish farming research in Kenya. A number of assumptions were made about catfish production characteristics in a given cycle (Table 1).

Table 1: The main assumptions used in the development of a production schedule for a 1-ha catfish farm in the Lake Victoria basin, Kenya (it is assumed that two ponds are simultaneously stocked with catfish fingerlings every month to be able to have continuous production). Assumed values are based on references discussed in the text.

Characteristic	**Assumed values**
Stocking density	5 catfish/m^2
Initial weight of catfish stocked	10 g
Cost of catfish fingerlings	5 KSh/individual
Survival at harvest	50%
Cycle length	28 weeks
Harvest weight catfish	442 g
Catfish price	120 KSh/kg
Yield-live catfish	8.84 ton/ha
FCR	3.8
Cost of supplementary feed/diet	13.8 KSh/kg
1 USD	78 KSh
Interest on loan	12%
Discounting rate	10%
Loan	70%
Equity	30%
Depreciation equipment	10 years
Depreciation ponds	20 years
Years for equipment and pond loans	10 years
Financing	KSh 948,000
Loan	KSh 663,600 (70%)
Equity	KSh 284,400 (30%)
Working capital	KSh 140,000
Other assumptions	
Area	1 ha
Pond area	0.08 ha
Pond cost	KSh 36,000/pond
Land cost	KSh 250,000/ha
Number of ponds in ha farm	12 ponds
Hourly wage	KSh 50
Month days	30 days
Batch cycle length	8 months
Averages annual mean temperature	25-27 ^{0}C
Average pond depth	0.8 m
Urea	
Cost	KSh 30/kg
Quantity	90 kg/ha
Diammonium Phosphate	
Cost	KSh 30/kg
Quantity	30 kg/ha
Agricultural Lime	
Cost	KSh 10/kg
Quantity	5000 kg/ha
Fishmeal	KSh 35/kg
Rice bran	KSh 8/kg
Wheat bran	KSh 10/kg
Land, house and store	KSh 500,000
Equipments	KSh 288,000
The operation system used is semi-intensive	

4.2 Production planning model

One pond model

Based on the assumptions in Table 1, a one pond (800 m^2) production model was developed. The pond previously limed at a rate of 5 tons ha^{-1}, was stocked with 4,000 catfish fingerlings (10 g) with five individuals /m^2. To stimulate growth of plankton, the pond was fertilized with urea at a rate of 90 kg ha^{-1} and diammonium phosphate (DAP) at a rate of 30 kg ha^{-1}. The fertilizer was applied once a week. The inorganic fertilizer provided an alternative or supplemental source of nitrogen and protein via phytoplankton conversion. The fish were also fed daily on a supplementary feed composed of 20% fish meal, 20% wheat bran and 60% rice bran. More of the rice bran was used because of its low price and its easy availability at the Ahero irrigation scheme (and other places in the basin). After every two weeks, the pond was sampled for fish growth measurements. Mean body weights (g) and percentage survival rates were determined. This was used to compute biomass of the fish in the pond after every two weeks. Based on this biomass, the fish were fed daily over a culture period of 28 weeks. At the end of the 28^{th} week the fish were harvested from the pond and net production determined then sold at Ksh 120 kg^{-1}. The main costs incurred during the operation were calculated and subtracted from the revenue (sales) at the end of the production period, see further in Appendix I.

Twelve pond model

The information from the one pond model was used to prepare a production planning model for a 1-ha catfish farm. The 1-ha farm comprised 12 ponds each measuring 800 m^2. Two ponds were simultaneously stocked with catfish fingerlings every month to be able to have continuous production. After the first six months in operation all the twelve ponds were stocked and in the eighth month the first two ponds were due for harvest. The design of the model was such that the operator could tell at a glance the total costs, income and operating surplus in a month and in the whole year of operation. In so doing, the farm operator would be able to budget in advance on what resources are needed for production. Using the model, the operator was also to choose what optimal levels of resources to use to give optimal operating surplus. By using the model, the farmer was for instance able to tell how many fingerlings or feed (and their respective costs) are needed at any particular time of operations.

After harvesting, the ponds were cleaned, repaired, limed and fertilized before restocking again. These activities lasted one month. Still based on the assumptions in Table 1, production was projected over a period of 10 years. The purpose of this was to focus on quantity harvest and sales and the accruing revenues (net cash incomes) over the years. This was also to discern if there was any gain as a result of the economies of scale in the operation (see Appendix II).

4.3 Profitability model

A profitability model was developed based on the results of the 1-ha production model. In determining the costs, the 1-ha farm was considered as a budgetary unit for a period of one year. The profitability model had the following main components: summary assumptions and results, investment and finance, operations statement, cash flow, balance sheet, profitability measurements and sensitivity analysis (see Appendix III). By entering the assumptions, the model gave the cash flow over the planning horizon. The model was also used to calculate the indicators of investment returns such as net present value (NPV), and internal rate of return (IRR), payback period and debt service coverage ratio. Such indicators are important in evaluating the profitability of the venture.

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

4.4 Planning farm operations

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

It should be noted that besides serving as a decision support tool for investment analysis, the profitability model can be used during operations as a planning tool year by year.

The balance sheet reflected the assets and liabilities during the operations. Profitability measurements NPV, IRR and financial ratios indicated the feasibility of the venture over the years (see Appendix III for details).

5 THE BUSINESS MODEL FOR THE CATFISH FARM

5.1 Production from one pond

Catfish fingerlings each weighing 10 g were stocked at a stocking density of 5 individuals /m^2 in a pond of 800 m^2. Based on the assumptions above, the percentage survival rates and mean body weights, the total biomass was determined over the 28 week growth period. The fish in the ponds were fed daily by assuming that the feed was distributed two to three times a day in equal portions. The average size by weight and the estimated total biomass of the catfish population in the pond were the basis for determining the total daily ration requirement. A general guideline for the daily feeding rate of catfish in water temperature above 24°C is given in Table 2.

Table 2: Guidelines for feeding rate of African catfish (Modified from Janssen 1987).

Mean body weight of fish (g)	Feeding ratio (% /biomass/day)
10-20	4.5 – 4.0
20-50	3.5 – 3.0
50-100	2.8 – 2.4
100-150	2.3 – 2.0
200-300	1.8 – 1.5
>300	1.5

The daily ration was calculated using the formula (Modified from Janssen 1987):

Daily feeding = F*(XY/1000) kg of feed.

Where:
X = Average body weight of catfish in grams
Y = Estimated total number of catfish in the pond
F = Feeding ratio (see different ratios in relation to body weight in (Table 2).

The supplementary diet was prepared using farm waste products of rice bran (60%) and wheat bran (20%) mixed with fishmeal (20%). The ponds were also fertilized once a week using urea and di-ammonium phosphate. Applying fertilizers stimulates the production of suitable natural organisms (phytoplankton and zooplankton) that serve as food for fish. At the end of the 28th week 2,000 fish were harvested from the pond and a net production of 884 kg/800m^2 was obtained and sold at Ksh 120/kg. These operations are summarized in Table 3. The pond was then cleaned, repaired, limed, fertilized and restocked again.

Table 3: Production data and cost of monoculture of the African catfish, density 5 fingerlings/m2, mean temperature 25-27 °C.

Week	**Survival rate (%)**	**No. of fish**	**Mean body weight (g)**	**Biomass (kg)**	**Feeding rate (%/ biomass /day)**	**Feeding (kg/800m ^{2}/day)**	**Cost of feeds (Ksh)**	**Fertilizing costs /two weeks (Ksh)**	**Total Costs ThKsh.**
0	100	4.000	10	40	5%	2	386	257	22,0
2	75	3.000	18	54	4%	2	417	257	2,0
4	65	2.600	29	75	4%	3	510	257	2,1
6	60	2.400	37	89	3%	3	515	257	2,1
8	60	2.400	50	120	3%	3	649	257	2,2
10	60	2.400	63	151	3%	4	730	257	2,3
12	55	2.200	80	176	2%	4	816	257	2,4
14	55	2.200	105	231	2%	5	1.026	257	2,6
16	55	2.200	130	286	2%	6	1.160	257	2,7
18	55	2.200	160	352	2%	7	1.292	257	2,9
20	50	2.000	203	406	2%	7	1.412	257	3,0
22	50	2.000	252	504	2%	8	1.461	257	3,0
24	50	2.000	318	636	2%	10	1.843	257	3,4
26	50	2.000	375	750	2%	11	2.174	257	3,7
28	50	2.000	442	884	2%	13	2.562	257	4,6
							16.95	3.852	60,9

The main costs incurred during the production cycle included: costs of fingerlings, feeds, fertilizers, lime, labour, security, transportation of feeds and fingerlings and harvesting. All costs were calculated and subtracted from the revenue at the end of the production cycle giving a net profit contribution of Kshs 45,100 (Table 4). For further details on items used in the production, their quantities, costs and values (see Appendix I).

Table 4: Summary: revenue, costs and net profit contribution from one pond 800 m^2.

Revenue:		
Sales Price	120	**Ksh./kg**
Income	106.1	**ThKsh.**
Costs:		
Other costs	**11.0**	
Feeding	**17.0**	
Fertilizing	**3.9**	
Fingerlings	**20.0**	
Labour	**8.7**	
Harvest cost	**0.4**	
Total Costs	**60.9**	
Net Profit Contribution	**45.1**	**ThKsh.**

5.2 Production from one hectare (twelve ponds) during the first year of operation

For the farmer to be able to have continuous production, two ponds were simultaneously stocked with catfish fingerlings every month (Table 5).With a harvest of 884 kg $pond^{-1}$, a net production of 9 tons ha^{-1} during the first year of operation was obtained. More yields were realized in subsequent years of production (see further in Appendix II).

Table 5: Production schedule for 1-ha catfish farm during first year of operations.

	N-POND PRODUCTION MODEL									**Pond**			**End**
	All numbers in ThKsh.									**cleaning**			**year 1**
Months		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**+liming**	**10**	**11**	**12**
Pond 1	Costs	**28**	**4**	**5**	**5**	**6**	**6**	**7**	**5**	**4**	**28**	**4**	**5**
	Income								**106**		**0**	**0**	**0**
	Operating	**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**102**	**-4**	**-28**	**-4**	**-5**
Pond 2	Costs	**28**	**4**	**5**	**5**	**6**	**6**	**7**	**5**	**4**	**28**	**4**	**5**
	Income								**106**		**0**	**0**	**0**
	Operating	**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**101**	**-4**	**-28**	**-4**	**-5**
Pond 3	Costs		**28**	**4**	**5**	**5**	**6**	**6**	**7**	**5**	**4**	**28**	**4**
	Income									**106**		**0**	**0**
	Operating		**-**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**102**	**-4**	**-28**	**-4**
Pond 4	Costs		**28**	**4**	**5**	**5**	**6**	**6**	**7**	**5**	**4**	**28**	**4**
	Income									**106**		**0**	**0**
	Operating		**-**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**101**	**-4**	**-28**	**-4**
Pond 5	Costs			**28**	**4**	**5**	**5**	**6**	**6**	**7**	**5**	**4**	**28**
	Income										**106**		**0**
	Operating			**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**102**	**-4**	**-28**
Pond 6	Costs			**28**	**4**	**5**	**5**	**6**	**6**	**7**	**5**	**4**	**28**
	Income										**106**		**0**
	Operating			**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**101**	**-4**	**-28**
Pond 7	Costs				**28**	**4**	**5**	**5**	**6**	**6**	**7**	**5**	**4**
	Income											**106**	
	Operating				**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**102**	**-4**
Pond 8	Costs				**28**	**4**	**5**	**5**	**6**	**6**	**7**	**5**	**4**
	Income											**106**	
	Operating				**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**101**	**-4**
Pond 9	Costs					**28**	**4**	**5**	**5**	**6**	**6**	**7**	**5**
	Income												**106**
	Operating					**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**102**
Pond10	Costs					**28**	**4**	**5**	**5**	**6**	**6**	**7**	**5**
	Income												**106**
	Operating					**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**101**
Pond 11	Costs						**28**	**4**	**5**	**5**	**6**	**6**	**7**
	Income												
	Operating						**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**
Pond 12	Costs						**28**	**4**	**5**	**5**	**6**	**6**	**7**
	Income												
	Operating						**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**
Total costs		56	64	73	83	94	106	65	66	65	111	108	105
Total income		0	0	0	0	0	0	0	212	212	212	212	212
Total operating surplus		-56	-	-73	-83	-94	-106	-65	146	147	101	104	107
End yr	**Net income**												**63**

5.3 Monitoring farm performance

An insight into the performance of the farm during operations was monitored using the profitability model. This is useful to the operator as it tells whether the venture is feasible and what would be the payback period of the investment. Later this would be used for farms in real life to plan their operations and cash flow. For instance, for a farmer who is in operation, the profitability model can be used as a tool to track the performance of the farm and see if the farmer is realizing sales and profits as projected (Figure 6).

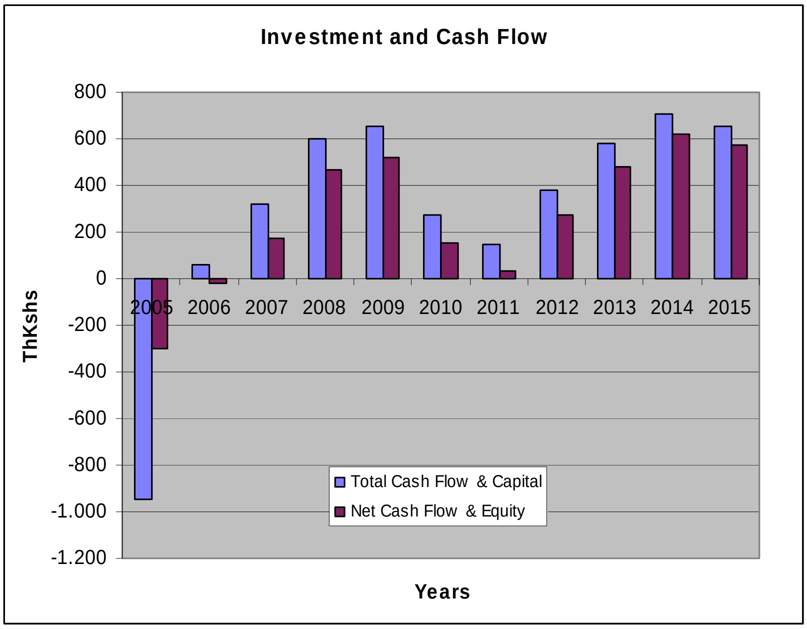

Figure 6: Investment and cash flow of 1-ha catfish farm over a period of 10years.

5.4 Investment costs

Before venturing into fish farming a farmer needs to have money (capital) to invest. The amount of money and kind of facilities required depends on the type of catfish farming programme, such as food fish or fingerling production. The investment may be described as land, buildings, ponds and start-up costs. Start-up costs, also known as initial costs, include those costs associated with starting a catfish farm. Some of the items in the start-up costs include: obtaining land, constructing ponds, digging water wells, constructing a farm house and store, installing pumps and pipe systems for water, digging drainage ditches, constructing access roads, feeding equipments and tanks.

Operating costs

Operating costs include fixed costs and variable costs. Fixed costs are associated with the long-term operation of a catfish farm. Examples include: taxes (on property), insurance, depreciation, interest, amortization payments (for repayment of borrowed money). These costs are often overlooked but must be considered in assessing the financial situation of a catfish farm. Variable costs are the costs that vary with the size of the catfish farm or the number of ponds being stocked. Larger farms (or stocking more ponds) have much greater total variable production costs than smaller farms. Examples include: feeds, seed/fingerlings, fuel and/or power, chemicals, fertilizers, harvesting costs, and labour.

Expected returns

Returns include the money that the catfish farmer receives from the sale of catfish. Profit is the most important return and is determined by subtracting the costs of production from the amount received when the catfish are sold. (Note: start-up costs, annual fixed costs, and variable production costs must all be used in calculating production costs.)

Returns from catfish farming may be reported as “gross” or “net” returns –the distinction between the two is important.

Gross return refers to the total amount of money received for the catfish that are sold. Not much consideration is given to how much it cost to produce the crop. Gross return is calculated by multiplying the total number of kilograms sold by the price received per kilogram for the fish.

Net return refers to the total amount of money remaining after all costs of production have been subtracted from gross returns. Net return is also known as profit. It is a more important measure of a catfish farm than gross return. Net return also reflects on the efficiency of the catfish farm.

These costs and returns can be summarized in table form (Table 6).

Table 6: Investment analysis (costs of production and expected returns).

Item	**Kilograms (kg)**	**Value (Kshs)**
Revenue		
Price		
Quantity harvested		
Catfish sales		
Total income		
Variable costs		
Fingerlings		
Feeds		
Fertilizer		
Lime		
Field labour: stock, feed, fertilize, harvest		
Labour: dyke repairs, levee repairs, after draining		
Security personnel		
Total variable costs		
Fixed costs		
Interest paid on a long term loan		
Ponds (Lease/rent)		
Total fixed costs		
Total costs		
Net cash farm income (income above variable costs)		
Non-cash adjustments to income		
Fish inventory adjustments		
Depreciation equipment		
Depreciation ponds		
Net farm income from operations		
Gain/loss on sale of capital assets		
Machinery		
Land		
Other		
Net farm income		

5.5 Risk assessment and sensitivity analysis

Sensitivity and risk assessment offered additional insights into the overall feasibility of the operation.

Risk assessment

NPV and IRR were used to asses the risk of the farm.The NVP is equal to the present value of future net cash flows, discounted at the cost of the capital. The NPV, calculated with 10% interest was positive, implying that the venture is feasible. The payback period (expected number of years required to recover the original investment) was four years (Figure 7). The quick payback period implies low risk in the investment.

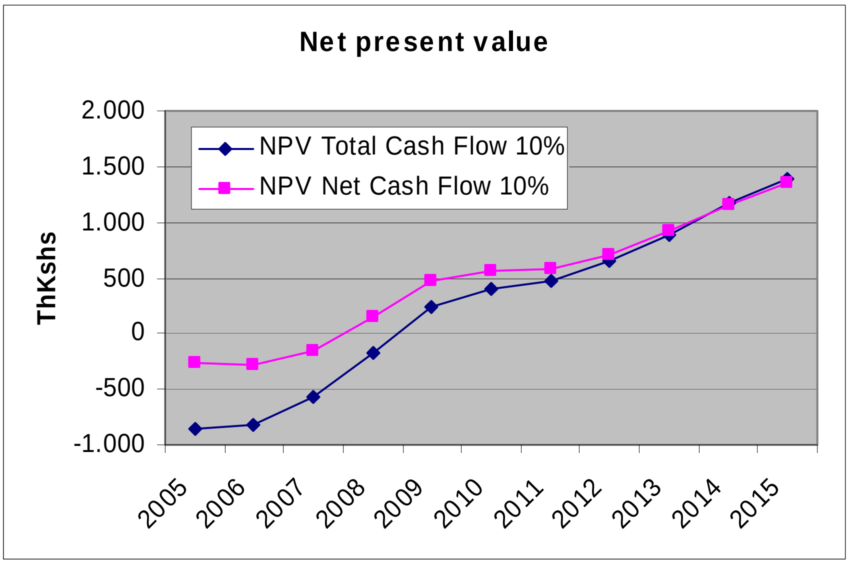

Figure 7: NPV of the catfish farm model.

The IRR is the discount rate that equates the present value of the project's expected cash inflows to the present value of the project's cost. The IRR on a project is its expected rate of return. If the internal rate of return exceeds the cost of the funds used to finance the project, a surplus remains after paying for the capital, and this surplus accrues to the farmer. The IRR for the 1-ha farm was positive and above zero meaning the venture is profitable to operate even if the planning horizon is only five years (Figure 8).

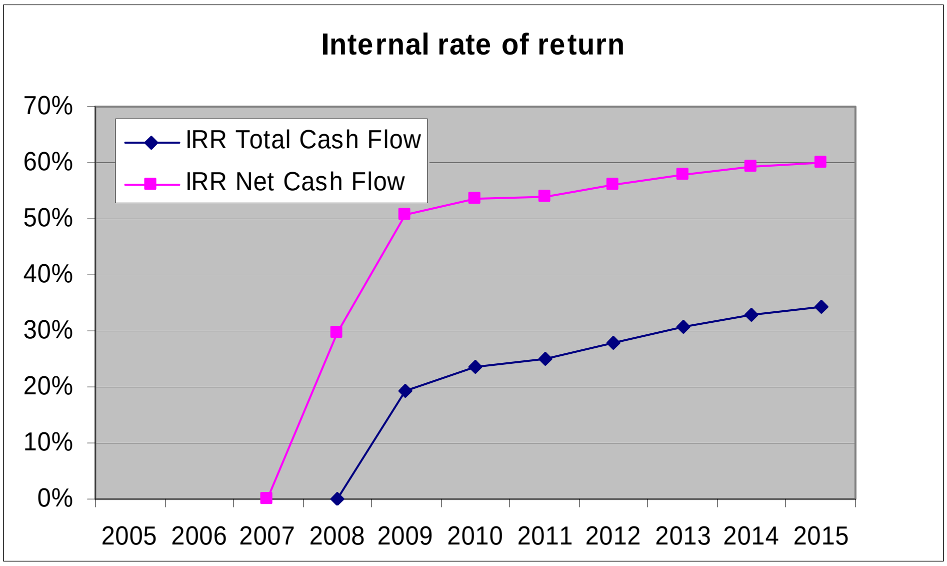

Figure 8: IRR of the catfish farm model.

A debt service coverage ratio of above one indicates that there is enough cash to pay interest and repayment of loans. A net current ratio of above one indicates that current assets are greater than current liabilities. Both the debt service coverage ratio and the net current ratio were above one (Figure 9).

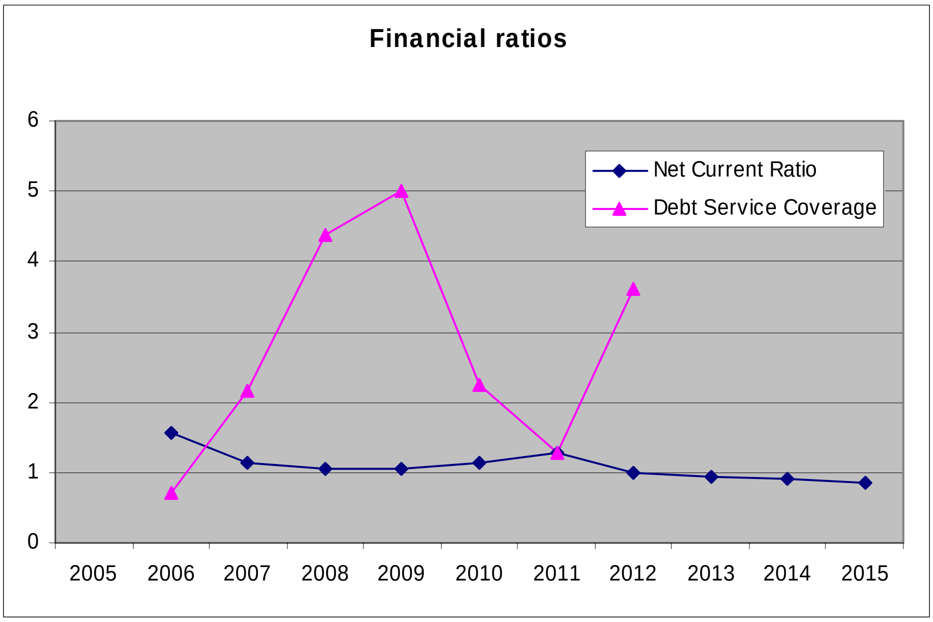

Figure 9: Financial ratios of the catfish culture model.

Sensitivity analysis

The profitability of the fish farming investment is most sensitive to the sales price of the products (Table 7 and Figure 10). The survival rate is the next factor and the stocking density comes third. It should be noted that a 20% decrease in sales price results in an IRR under 10% which is not acceptable.

Table 7: Sensitivity analysis of stocking density, cost of feed, cost of fingerlings, survival rates and sale price of the catfish culture model.

Deviations	Values	Stocking density/m^2	IRR of total capital stocking Densit	Cost of feed (Ksh)	IRR of total capital cost of Feed	Cost of fingerlings (Ksh)	IRR of total capital cost of fingerlings	Survival rates (biomas) kg	IRR of total capital survival rates	Sales price (Ksh)	IRR of total capital sales price
-50%	50%	2.5	0%	6.9	44%	2.5	47%	442	0%	60	0%
-40%	60%	3	0%	8.3	42%	3	45%	530	0%	72	0%
-30%	70%	3.5	10%	9.7	40%	3.5	42%	619	0%	84	0%
-20%	80%	4	19%	11	38%	4	40%	707	13%	96	8%
-10%	90%	4.5	27%	12.4	36%	4.5	37%	796	24%	108	22%
0%	**100%**	**5**	**34%**	**13.8**	**34%**	**5**	**34%**	**884**	**34%**	**120**	**34%**
10%	110%	5.5	41%	15.2	32%	5.5	31%	972	44%	132	46%
20%	120%	6	47%	16.6	30%	6	29%	1.061	53%	144	56%
30%	130%	6.5	54%	17.9	28%	6.5	26%	1.149	61%	156	67%
40%	140%	7	60%	19.3	26%	7	23%	1.238	70%	168	78%
50%	150%	7.5	66%	20.7	24%	7.5	21%	1.326	79%	180	88%

On the cost side, the graph below shows that the profitability is much less sensitive to deviations; even a 50% increase in the cost of fingerlings still results in an IRR of 20% or well above the minimum marginal attractive rate of return (MARR).

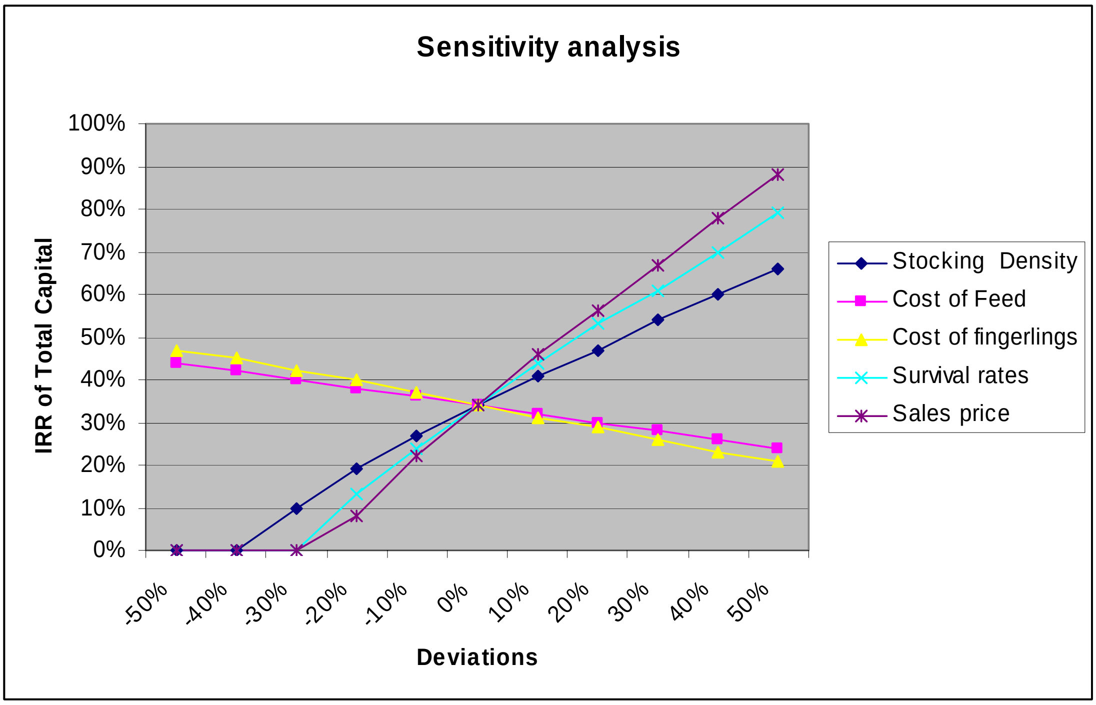

Figure 10: Sensitivity analysis of stocking density, survival rates, cost of feed, cost of fingerlings and sales price of the catfish culture model.

6 DISCUSSION

The purpose of this study was to develop a tool to assess the profitability of fish farming. As a case study, catfish farming in Kenya was evaluated. It is critical for farmers and investors to understand how to calculate and interpret the profitability of aquaculture businesses. It is envisaged that the profitability model will become a valuable management tool to aquaculture farmers and investors and help facilitate a more market-driven production management. The information generated will provide prospective and existing fish farmers with appropriate tools to determine the profitability of their farms and also help lending institutions better asses the viability of aquaculture projects and reduce the rate of failure in loan repayment.

Subsistence aquaculture is the main form of aquaculture practiced in Kenya. This may be attributed to a number of factors perhaps the foremost being a lack of initiative to run fish farming as a business. There has been no research geared towards the promotion of commercial aquaculture and local information on this potentially important sector is difficult to find. This could be attributed to the fact that farmers have not been keen on taking a risk and invest in an enterprise with no performance benchmarks. Furthermore, farmers are unable to appraise risks and opportunities of investing in aquaculture in the country.

In this study, a profitability model to asses the feasibility of fish farming in the Lake Victoria basin, Kenya, has been developed. It is important for farmers and investors to understand that a considerable amount of capital is needed before going into catfish farming or fish farming in general. Also, the operation must be able to return the capital with profit. Land is often a major investment. Equipment, facilities, seed, labour and other inputs are needed to produce catfish. The amount and kind of needs depends on the type of production system (extensive, semi-intensive or intensive). It also depends on the type of catfish farming programme, such as food fish or fingerlings.

During this study it was estimated that a farmer may require Ksh 36,000 to construct one pond of the size 800 m^2 (or 0.08 ha). In constructing such a pond, about 400 man-hours were used, paid at a rate of Ksh 50 $hour^{-1}$ costing a total of Ksh 20,000. The construction of an inlet and outlet using PVC pipes and other accessories such as harvesting sump and gate valves cost Ksh 10,000. The technician supervising construction on site was paid Ksh 6,000. To construct one pond of 800 m^2 and accommodate a medium sized house and store, a farmer may require 0.2 ha estimated to cost Ksh 50,000. The housing would probably cost a further Ksh 200,000. A farmer will therefore require an initial capital outlay of Ksh. 300,000 to start such a small fish farm with only one fishpond. These costs are indicated in Appendix I. In constructing 12 ponds (each 800 $m^{2)}$ in a one-ha farm, it was expected that the farmer was to benefit from the economies of scale. To construct and operate the 1-ha fish farm the farmer requires at least Ksh 1 million (USD ≈ 13,000) as the start-up capital. The venture was financed through 30% owner's equity and 70% loans (see Appendix III – assumptions and results).

From Table 3 and Table 4, it is noted that the costs of fingerlings are higher than any other item in the operation. The cost of feed was also high. These two items (fingerlings and feeds) were the most expensive of the production costs. Lower prices for fingerlings and feeds to prospective fish farmers would make fish farming more attractive. The transportation costs of feeds and fingerlings would also be considerable, depending on the distance to millers and a hatchery and the logistics of transporting fingerlings. The operation was also found to be highly sensitive to changes in stocking density, survival rates and sales price. Any slight changes in these had a tremendous effect on the IRR of total capital. For instance a 20% decrease in sales price resulted in an IRR under 10% which is not acceptable (Figure 10).

The annual production figures from the present study for one pond of 800 m^2 (0.9 tons $year^{-1}$), or 9 tons ha^{-1} $year^{-1}$ (during the first year of operation) are comparatively higher than those reported in the country for *Clarias* monoculture (2 tons ha^{-1} $year^{-1}$) and *Clarias*-tilapia polyculture (0.61- 4.1 tons ha^{-1} $year^{-1}$) at experimental study sites at Kibos and Sagana (De Graaf 1994, Omondi *et al.* 2001).Work done in Nigeria documented catfish yields of 6-16 tons ha^{-1} $year^{-1}$ (Janssen 1987), and in Bangladesh an experiment on catfish farming reported yields of at 8-12 tons ha^{-1} $year^{-1}$ (Rahman *et al.* 1992). Small scale farmers in western Ivory Coast operating 0.5 -2 ha ponds had reported 30 tons ha^{-1} $year^{-1}$ for *Clarias* monoculture compared to 10-12 tons ha^{-1} $year^{-1}$ of tilapia (mainly *O.niloticus*) monoculture (Moehl 1999).

The yields of 9 tons ha^{-1} $year^{-1}$ in the first year of operation and 12.4 tons ha^{-1} $year^{-1}$ in the second year of operation look impressive (Appendix II). It would be interesting to test this model in a real farm situation and compare the actual yields with the modelled yields and also the profits realised. From the modelled results, operating a 1-ha farm could give a net cash income of Ksh 63,000 during the first year of operation and Ksh 345,000 in the second year of operation. The financial cash flow of the operation over a 10 year period is as shown in Figure 6 and Appendix III.

An insight into the economical feasibility of the farm during operations was gained using the profitability model. This was useful in determining whether the enterprise was feasible. Indicators of investment returns such as payback period, NPV, and IRR were determined. The NPV was positive, implying that the venture is feasible. The payback period (expected number of years required to recover the original investment) was four years (Figure 7). An NPV of zero signifies that the project's cash flow is exactly sufficient to repay the invested capital and to provide the required rate of return on that capital. If a project has a positive NPV, then it is generating more cash than is needed to service its debt and provide the required return to shareholders (Brigham and Houston 2004). The IRR for the farm was above a preset minimum called the marginal attractive rate of return (MARR), meaning the venture was profitable to operate (Figure 8).

The debt service coverage ratio was above 1.5 showing that the cash flow from the operation was well above the repayment and interest of loans, which have to be paid. The net current ratio was above one, meaning the current assets were not less than current liabilities, therefore the investment is solid and robust (Figure 9).

Any farmer or potential investor must analyse the costs of operating an aquaculture venture more carefully. Currently, agriculture and horticulture provide better returns from lower investments. However, the potential for an annual return of Ksh 345,000 (or USD ≈ 4,400) from *Clarias* monoculture should attract those with capital to invest in the amount indicated (Ksh 1 million or USD ≈ 13,000) that could be recovered in five years (see Appendix II & III). All the main assumptions made here about cost, prices and other important parameters like stocking density, survival rates and growth, are based on literature references and assessed and confirmed by personal experience.

Record keeping on fish farming is poor. Due to paucity of data, the economic performance of the farms could not be assessed. Lack of records on vital factors such as production costs makes it impossible to determine the profitability of the enterprises. There is need to inculcate the culture of keeping records if fish farming is to compete and be ranked with other alternative agribusinesses. To help the farmers understand the management, economic and business aspects of fish farming, a guide to record keeping and data collection was developed as well as a pamphlet with such information.

At the current interest rate of 12% on payable loans, the farmer can only earn his money back after four years (Appendix III). However, the capital requirements for the brood stock, hatchery and nursery, and out-grow systems may be beyond the financial means of many small producers. Further, given the huge initial capital outlay for investment of at least Ksh 1 million (USD ≈ 13,000) for a 1-ha farm, there is need for the government and financial institutions to avail loans or other incentives to fish farmers and those who may want to invest in the industry.

Based on the assumptions and analysis of the profitability model, catfish farming appears feasible and profitable along the Lake Victoria basin. However, for a sustainable development of the industry, policy makers and farmers are challenged with the responsibility of planning and conducting aquaculture development in a sustainable way whereby social, environmental and economic goals are simultaneously satisfied (Martinez-Cordero and Leung 2004).

This profitability model does not fully take into account all the uncertainties and risks associated with different processes of catfish production. In the future, a Monte Carlo simulation could be used to study the effects of changing many parameters simultaneously.

7 CONCLUSION

During this study a decision support tool, the profitability model, was developed and will be used to assess the profitability of fish farming enterprises in Kenya and hopefully also in other parts of the world.

This model will be a valuable management tool to aquaculture practicing farmers as well as potential farmers, investors, financial institutions and banks. The profitability model can be used in planning and also during the operations of the farm.

For our case study of catfish farming in the Lake Victoria basin the results were as follows:

- Based on the assumptions and analysis of the profitability model, catfish farming appears feasible and profitable along the Lake Victoria basin yielding 9 tons ha^{-1} $year^{-1}$ in the first year of operations and 12 tons ha^{-1} $year^{-1}$ during the second year of operations (Appendix II). However, the model needs to be tested in a real farm situation, comparing the actual yields with the modelled yields.
- Operating a 1-ha farm could give a net cash income of Ksh 63,000 during the first year of operation and Ksh 345,000 in the second year of operation. The potential for an annual return of Ksh 345,000 (or USD ≈ 4,400) from *Clarias* monoculture should attract those with capital to invest, that could be recovered in five years.
- An initial capital outlay of at least Ksh 1 million (USD ≈ 13,000) is required as an investment to start a 1-ha fish farm. At the beginning, it may not be possible for farmers to raise this money. Therefore they need access to loans and other incentives.
- The NPV obtained was positive and the project also resulted in an acceptable IRR. The investment has a payback period of four years and low risks of investment (Figures 6, 7 & 8). However, we should keep in mind that this only holds true based on the assumptions in Table 1.
- The debt service coverage ratio was above 1.5 showing that the cash flow from the operations is well above the repayment and interest of loans, which have to be paid (Figure 9).
- The sensitivity analysis shows that the profitability of the fish farming investment is most sensitive to the sales price of the products, survival rates and stocking density. For instance, a 20% decrease in sales price results in an IRR under 10% which is not acceptable (Table 7 and Figure 10).

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

During this study two other documents were developed:

- Pamphlet/Brochure: Fish Farming-Getting Started (Appendix IV)

- Record keeping and profit evaluation of small scale fish farming in Kenya (Appendix V)

It is envisaged that the documents will assist fish farmers to know what they need before going into fish farming and to understand and manage fish farming as a business. Also these records can be shared by the government agencies formulating policies and developing programmes for the development of fish culture in the country.

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APPENDICES

Appendix I	**One pond model (800 m2)**
Appendix I (a)	Production data on monoculture of the African catfish, stocking density 5 fingerlings/m^2, mean temperature 25-27 °C.
Appendix I (b)	Main data, main assumptions and summary of operating one pond 800 m^2
Appendix I (c)	Main costs used in the one pond (800 m^2) model.
Appendix II	Production schedule for 1-ha fish farm in L. Victoria basin, Kenya. Two ponds are simultaneously stocked with catfish fingerlings every month to be able to have continuous production throughout the year. Operating costs, income and operating surplus are calculated on a monthly basis. On the 8th month each pond is harvested. Pond cleaning, repairs and liming takes a month before the pond is fertilized and restocked again.
Appendix II (a)	1- ha farm: Operating costs, income and operating surplus during the first (1st) and second (2nd) year of production.
Appendix II (b)	1-ha farm: Operating costs, income and operating surplus during the third (3rd) and fourth (4th) year of production.
Appendix II ©	1-ha farm: Operating costs, income and operating surplus during the fifth (5th) and sixth (6th) year of production.
Appendix II (d)	1-ha farm: Operating costs, income and operating surplus during the seventh (7th) and eighth (8th) year of production.
Appendix II (e)	1-ha farm: Operating costs, income and operating surplus during the ninth (9th) and tenth (10th) year of production.
Appendix III	Profitability model: The profitability model had the following main components: summary assumptions and results, investment and finance, operations statement, cash flow, balance sheet and profitability measurements. By entering in assumptions, the model gave the cash flow over the planning horizon.
Appendix III (a)	Profitability model: Summary assumptions and results.

Appendix I: One pond model (800 m²)

Appendix I.(a) Production data on monoculture of the African catfish, stocking density 5 fingerlings/m², mean temperature 25-27 °C

Week	Survival rate (%)	No of fish	Mean body weight (g)	Biomass (Kg)	Feeding rate(%/ biomass /day)	Feeding (Kg/800m²/day)	Cost of feeds (Ksh)	Fertilizing costs /two weeks (Ksh)	Total Costs ThKsh.
0	100	4.000	10	40	5%	2	386	257	22,0
2	75	3.000	18	54	4%	2	417	257	2,0
4	65	2.600	29	75	4%	3	510	257	2,1
6	60	2.400	37	89	3%	3	515	257	2,1
8	60	2.400	50	120	3%	3	649	257	2,2
10	60	2.400	63	151	3%	4	730	257	2,3
12	55	2.200	80	176	2%	4	816	257	2,4
14	55	2.200	105	231	2%	5	1.026	257	2,6
16	55	2.200	130	286	2%	6	1.160	257	2,7
18	55	2.200	160	352	2%	7	1.292	257	2,9
20	50	2.000	203	406	2%	7	1.412	257	3,0
22	50	2.000	252	504	2%	8	1.461	257	3,0
24	50	2.000	318	636	2%	10	1.843	257	3,4
26	50	2.000	375	750	2%	11	2.174	257	3,7
28	50	2.000	442	884	2%	13	2.562	257	4,6
							16.954	3.852	60,9

Apendix I.(b).Main data, main assumptions and summary of operating one pond 800 m²

MAIN DATA:				SUMMARY:		
1) Stocking weight of individual fingerling =		10	**g**	Revenue:		
2) Stocking density =		5	**fingerlings/m2**	**Sales Price**	120	**Kshs/kg**
				Income	106,1	**TKshs**
4) Feed ingredients				Costs:		
Fishmeal	**20%**	35	**Kshs/kg**	**Othe costs**	**11,0**	
Wheat bran	**20%**	10	**Kshs/kg**	**Feeding**	**17,0**	
Rice bran	**60%**	8	**Kshs/kg**	**Fertilizing**	**3,9**	
Supplementary feed average cost		13,8	**Kshs/kg**	**Fingerlings**	**20,0**	
5)Cost of fingerlings:				**Labour**	**8,7**	
Cost of individual fingerling =		5	**Kshs**	**Harvest cost**	**0,4**	
Cost of fingerlings to stock in 800m² pond = 5 x 4000 = Kshs 20.000				Total Costs	**60,9**	
				Net Profit Contribution	45,1	**TKshs**

MAIN ASSUMPTIONS:

Daily ration for catfish in a pond

Mean body weight (g)	Feeding rate (%/biomass/day)
10-20	**4,5-4,0**
20-50	**3,5-3,0**
50-100	**2,8-2,4**
100-150	**2,3-2,0**
200-300	**1,8-1,5**
>300	**1,5**

a. Average body weight of catfish = X g

b. Estimated total no. of catfish in the pond = Y

c. Total biomass in the pond = X × Y = XY g or (XY/1000)kg

d. Daily ration for catfish of average mean body weight 10 g = 4.5% of body weight

e. Total daily ration required for catfish biomass of (XY/1000) kg = 4,5 *(XY/1000) kg of feed

Appendix I.©. Main costs used in the one pond (800 m^2) model

Labour									
1)Stocking fingerlings in 1 pond (needs 2 man hour paid at Kshs		100	Kshs/pond	Fertilizer application					
2)Feeding fish in 1 pond of size 800m^2,needs 1/3 of one man hours/day for 210				Urea: 3.42 kg/week/800m^2					
(1man hour = Kshs 50). Man hour cost = 1/3x50x		3.500	Kshs/pond	DAP: 0.86 kg/week/800m^2					
3)Fertilizing 1 pond:1/6 of one man hours per week (28				Total fertilizer in a week in a pond 800m^2					
(1 man hour = Kshs 50). Man hours cost =		233	Kshs/pond	Item	cost/kg	Kg/800m^2/week		Cost/week	
4)Security at site: Eight man hours per day for 365				Fertilizer					
(1 man hour = Kshs 20). Man hours cost =	58.400			Urea	30	3,42		102,6	
operating 12 ponds => cost for 1		4.867	Kshs	DAP	30	0,86		25,8	
Total labour costs		8.700	Kshs					128,4	
Other costs					Cost/Kg	Kg/800m2		Cost per	
Transportation of fingerlings (from source		2.500	Kshs	Lime	10	400		4	TKshs
Transportation of feeds (from source to		4.000	Kshs						
Pond repair and maintenance		1.000	Kshs	Fixed costs (ThKsh.)					
Repair of store & equipments(wheelburrows, Jembes,		1.500	Kshs	Harvesting gear		8			
Repair of fishing gear/nets		500	Kshs	Fencing		17			
Fuel/oil to pump water from		1.500	Kshs	Farm Equipments		18			
Total		11.000	Kshs	Total Fixed costs		43			
Harvesting costs = Kshs 0.5/kg of fish		0,4	TKshs	Investment in (ThKsh.)					
				Land, house and		500			
				Pond		288			
				Other		20			
				Working capital		140			
				Loan interest		12%			

Appendix II.
Production schedule for 1-ha fish farm in L. Victoria basin, Kenya.Two ponds are simultaneously stocked with catfish fingerlings every month to be able to have continuous production throughout the year. Operating costs, income and operating surplus are calculated on a monthly basis.On the 8th month each pond is harvested. Pond cleaning, repairs and liming takes a month before the pond is fertilized and restocked again.

Appendix II(a). 1- ha farm: Operating costs, income and operating surplus during the first (1st) and second (2nd) year of production.

	N-POND PRODUCTION MODEL											End						cleaning +							End
	All numbers in ThKsh.								cleaning +			Year 1						liming							Yr 2
Months		1	2	3	4	5	6	7	8	liming	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Pond 1	Costs	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6
	Income								106		0	0	0	0	0	0	0	106		0	0	0	0	0	0
	Operating Surplus	-	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6
Pond 2	Costs	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6
	Income								106		0	0	0	0	0	0	0	106		0	0	0	0	0	0
	Operating Surplus	-	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6
Pond 3	Costs		28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6
	Income									106		0	0	0	0	0	0	0	106		0	0	0	0	0
	Operating Surplus		-	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6
Pond 4	Costs		28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6
	Income									106		0	0	0	0	0	0	0	106		0	0	0	0	0
	Operating Surplus		-	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6
Pond 5	Costs			28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5
	Income										106		0	0	0	0	0	0	0	106		0	0	0	0
	Operating Surplus			-	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5
Pond 6	Costs			28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5
	Income										106		0	0	0	0	0	0	0	106		0	0	0	0
	Operating Surplus			-	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5
Pond 7	Costs				28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5
	Income											106		0	0	0	0	0	0	0	106		0	0	0
	Operating Surplus				-	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5
Pond 8	Costs				28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5
	Income											106		0	0	0	0	0	0	0	106		0	0	0
	Operating Surplus				-	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5
Pond 9	Costs					28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4
	Income												106		0	0	0	0	0	0	0	106		0	0
	Operating Surplus					-	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4
Pond10	Costs					28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4
	Income												106		0	0	0	0	0	0	0	106		0	0
	Operating Surplus					-	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4
Pond	Costs						28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28
	Income													106		0	0	0	0	0	0	0	106		0
	Operating Surplus						-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28
Pond	Costs						28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28
	Income													106		0	0	0	0	0	0	0	106		0
	Operating Surplus						-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28

Total Costs		56	64	73	83	94	106	65	66	65	111	108	105	101	102	106	65	66	65	111	108	105	101	102	106
Total Income		0	0	0	0	0	0	0	212	212	212	212	212	212	0	0	0	212	212	212	212	212	212	0	0
Total Operating Surplus		-	-	-	-	-	-	-	146	147	101	104	107	111	-	-	-	146	147	101	104	107	111	-	-106
End Yr	Net Income												63												345

Appendix II(b).1-ha farm: Operating costs, income and operating surplus during the third (3rd) and fourth (4th) year of production.

													End												End
	N-POND PRODUCTION MODEL												Year												Yr
	All numbers in ThKsh.												3												4
Months		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Pond 1	Costs	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5
	Income	0	106		0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0
	Operating Surplus	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5
Pond 2	Costs	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5
	Income	0	106		0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0
	Operating Surplus	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5
Pond 3	Costs	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4
	Income	0	0	106		0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0
	Operating Surplus	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4
Pond 4	Costs	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4
	Income	0	0	106		0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0
	Operating Surplus	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4
Pond 5	Costs	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28
	Income	0	0	0	106		0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0
	Operating Surplus	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28
Pond 6	Costs	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28
	Income	0	0	0	106		0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0
	Operating Surplus	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28
Pond 7	Costs	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4
	Income	0	0	0	0	106		0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0
	Operating Surplus	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4
Pond 8	Costs	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4
	Income	0	0	0	0	106		0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0
	Operating Surplus	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4
Pond 9	Costs	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5
	Income	0	0	0	0	0	106		0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106
	Operating Surplus	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102
Pond10	Costs	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5
	Income	0	0	0	0	0	106		0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106
	Operating Surplus	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101
Pond	Costs	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7
	Income	0	0	0	0	0	0	106		0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0
	Operating Surplus	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7

Pond	Costs	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7
	Income	0	0	0	0	0	0	106		0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0
	Operating Surplus	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7
Total Costs		65	66	65	111	108	105	101	102	106	65	66	65	111	108	105	101	102	106	65	66	65	111	108	105
Total Income		0	212	212	212	212	212	212	0	0	0	212	212	212	212	212	212	0	0	0	212	212	212	212	212
Total Operating Surplus		-65	146	147	101	104	107	111	-102	-106	-65	146	147	101	104	107	111	-102	-106	-65	146	147	101	104	107
End Yr	Net Income												671												755

Appendix II©.1-ha farm: Operating costs, income and operating surplus during the fifth (5th) and sixth (6th) year of production.

	N-POND PRODUCTION MODEL												End		cleaning +										
	All numbers in ThKsh.												Yr 5		liming									End Yr 6	
Months		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Pond 1	Costs	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4
	Income	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0
	Operating	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4
Pond 2	Costs	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4
	Income	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0
	Operating	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4
Pond 3	Costs	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5
	Income	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106
	Operating	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102
Pond 4	Costs	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5
	Income	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106
	Operating	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101
Pond 5	Costs	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7
	Income	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0
	Operating	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7
Pond 6	Costs	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7
	Income	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0
	Operating	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7
Pond 7	Costs	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6
	Income	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0
	Operating	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6
Pond 8	Costs	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6
	Income	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0
	Operating	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6
Pond 9	Costs	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6
	Income	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0
	Operating	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6
Pond10	Costs	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6
	Income	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0
	Operating	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6
Pond	Costs	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5

	Income	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0
	Operating	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5
Pond	Costs	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5
	Income	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0
	Operating	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5
Total Costs		101	102	106	65	66	65	111	108	105	101	102	106	65	66	65	111	108	105	101	102	106	65	66	65
Total Income		212	0	0	0	212	212	212	212	212	212	0	0	0	212	212	212	212	212	212	0	0	0	212	212
Total Operating Surplus		111	-	-	-	146	147	101	104	107	111	-102	-106	-65	146	147	101	104	107	111	-102	-	-65	146	147
End Yr	Net Income												345												671

Appendix II(d).1-ha farm: Operating costs, income and operating surplus during the seventh (7th) and eighth (8th) year of production.

	N-POND PRODUCTION MODEL												End					cleaning +							End
	All numbers in ThKsh.												Yr 7					liming							Yr 8
Months		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Pond 1	Costs	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6
	Income	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0
	Operating	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6
Pond 2	Costs	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6
	Income	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0
	Operating	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6
Pond 3	Costs	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6
	Income	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0
	Operating	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6
Pond 4	Costs	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6
	Income	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0
	Operating	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6
Pond 5	Costs	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5
	Income	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0
	Operating	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5
Pond 6	Costs	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5
	Income	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0
	Operating	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5
Pond 7	Costs	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5
	Income	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0
	Operating	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5
Pond 8	Costs	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5
	Income	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0
	Operating	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5
Pond 9	Costs	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4
	Income	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0
	Operating	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4
Pond10	Costs	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4
	Income	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0

	Operating	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4
Pond	Costs	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28
	Income	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0
	Operating	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28
Pond	Costs	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28
	Income	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0
	Operating	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28
Total Costs		111	108	105	101	102	106	65	66	65	111	108	105	101	102	106	65	66	65	111	108	105	101	102	106
Total Income		212	212	212	212	0	0	0	212	212	212	212	212	212	0	0	0	212	212	212	212	212	212	0	0
Total Operating Surplus		101	104	107	111	-	-	-	146	147	101	104	107	111	-102	-	-65	146	147	101	104	107	111	-102	-106
End Yr	Net Income												755												345

Appendix II(e).1-ha farm: Operating costs, income and operating surplus during the ninth (9th) and tenth (10th) year of production.

	N-POND PRODUCTION MODEL											End yr												End
	All numbers in ThKsh.											9												Yr 10
Months		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Pond 1	Costs	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5
	Income	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0
	Operating	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5
Pond 2	Costs	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5
	Income	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0
	Operating	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5
Pond 3	Costs	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4
	Income	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0
	Operating	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4
Pond 4	Costs	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4
	Income	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0
	Operating	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4
Pond 5	Costs	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28
	Income	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0
	Operating	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28
Pond 6	Costs	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28
	Income	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0
	Operating	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28
Pond 7	Costs	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4
	Income	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0
	Operating	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4
Pond 8	Costs	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4
	Income	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0
	Operating	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4	-28	-4	-5	-5	-6	-6	-7	101	-4
Pond 9	Costs	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5	4	28	4	5	5	6	6	7	5
	Income	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	106
	Operating	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102	-4	-28	-4	-5	-5	-6	-6	-7	102

Pond10	Costs	**5**	**5**	**6**	**6**	**7**	**5**	**4**	**28**	**4**	**5**	**5**	**6**	**6**	**7**	**5**	**4**	**28**	**4**	**5**	**5**	**6**	**6**	**7**	**5**
	Income	**0**	**0**	**0**	**0**	**0**	**106**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**106**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**106**
	Operating	**-5**	**-5**	**-6**	**-6**	**-7**	**101**	**-4**	**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**101**	**-4**	**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**101**
Pond	Costs	**4**	**5**	**5**	**6**	**6**	**7**	**5**	**4**	**28**	**4**	**5**	**5**	**6**	**6**	**7**	**5**	**4**	**28**	**4**	**5**	**5**	**6**	**6**	**7**
	Income	**0**	**0**	**0**	**0**	**0**	**0**	**106**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**106**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Operating	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**102**	**-4**	**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**102**	**-4**	**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**
Pond	Costs	**4**	**5**	**5**	**6**	**6**	**7**	**5**	**4**	**28**	**4**	**5**	**5**	**6**	**6**	**7**	**5**	**4**	**28**	**4**	**5**	**5**	**6**	**6**	**7**
	Income	**0**	**0**	**0**	**0**	**0**	**0**	**106**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**106**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Operating	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**101**	**-4**	**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**	**101**	**-4**	**-28**	**-4**	**-5**	**-5**	**-6**	**-6**	**-7**
Total Costs		65	66	65	111	108	105	101	102	106	65	66	65	111	108	105	101	102	106	65	66	65	111	108	105
Total Income		0	212	212	212	212	212	212	0	0	0	212	212	212	212	212	212	0	0	0	212	212	212	212	212
Total Operating Surplus		-	146	147	101	104	107	111	-	-	-65	146	147	101	104	107	111	-102	-	-65	146	147	101	104	107
End Yr	Net Income												671												755

Appendix III.

Profitability model: The profitability model had the following main components: summary assumptions and results, investment and finance, operations statement, cash flow, balance sheet, profitability measurements and sensitivity analysis. By entering in assumptions, the model gave the cash flow over the planning horizon.

Appendix III (a). Profitability model: Summary assumptions and results.

		Assumptions and Results						
		2005		Discounting Rate		10%		
Investment:				Planning Horizon		10	years	
Land and House+Store		**500**	ThKsh					
Pond Construction	**100%**	**288**	ThKsh	_	_	Total Cap.	Equity	Dividend
Other		**20**	ThKsh	NPV of Cash Flow		1.398	1.356	
Total		808	ThKsh	Internal Rate of Return		34%	60%	
Financing:								
Working Capital		**140**	ThKsh	Capital/Equity		0,7		
Total Financing		948	ThKsh	after 10 years				
Equity	**100%**	**30%**						
Loan Repayments	**100%**	**10**	**years**					
Loan Interest	**100%**	**12%**						
Operations:			2006	2007	2008	2009	2010	
Sales Quantity	**100%**	_	**0,9**	**1,2**	**1,4**	**1,6**	**1,2**	**ton/year**
Sales Price	**100%**	_	**120000,0**	**120000,0**	**120000,0**	**120000,0**	**120000,0**	**kshs/ton**
Variable Cost	**100%**	**902.259,0**	**kshs/ton**	_	_	_	_	_

Fixed Cost	100%	43000	Kshs/year	_	_	_	_	_
Inventory Build-up		_	0	_	_	_	_	_
Debtors	25%	of turnover						
Creditors	15%	of variable cost						
Dividend	100%	of profit						

Appendix III (b). Profitability model: Investment and finance

Year		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Investment and Financing			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Investment:													
Buildings		500	**480**	**460**	**440**	**420**	**400**	**380**	**360**	**340**	**320**	**300**	
Equipment		288	**245**	**202**	**158**	**115**	**72**	**29**	**29**	**29**	**29**	**29**	
Other		20	**16**	**12**	**8**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	
Booked Value		808	741	674	606	539	472	409	389	369	349	329	
Depreciation:													
Depreciation Buildings	**4%**		**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	200
Depreciation Equipm.	**15%**		**43**	**43**	**43**	**43**	**43**	**43**					259
Depreciation Other	**20%**		**4**	**4**	**4**	**4**	**4**	**0**	**0**	**0**	**0**	**0**	20
Total Depreciation			67	67	67	67	67	63	20	20	20	20	479
Financing:		948											
Equity	**30%**	284											
Loans	**70%**	664											
Repayment	**10**		**0**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	597
Principal		**664**	**664**	**597**	**531**	**465**	**398**	**332**	**265**	**199**	**133**	**66**	
Interest	**12%**	**0**	**80**	**80**	**72**	**64**	**56**	**48**	**40**	**32**	**24**	**16**	510

Loan Managem. Fees	**2%**	**13**											

Appendix III ©. Profitability model:Operations statement.

Year		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Operations Statement													
Sales		-	**0,884**	**1,2376**	**1,410864**	**1,5942763**	**1,2435355**	**1,243536**	**1,243536**	**1,243536**	**1,243536**	**1,243536**	12,58795
Price		-	**120.000**	**120.000**	**120.000**	**120.000**	**120.000**	**120.000**	**120.000**	**120.000**	**120.000**	**120.000**	-
Revenue		-	**106.080**	**148.512**	**169.304**	**191.313**	**149.224**	**149.224**	**149.224**	**149.224**	**149.224**	**149.224**	**1.510.554**
		-	-	-	-	-	-	-	-	-	-	-	-
Variable	**902259**	-	**797.597**	**1.116.636**	**1.272.965**	**1.438.450**	**1.121.991**	**1.121.991**	**1.121.991**	**1.121.991**	**1.121.991**	**1.121.991**	**11.357.595**
Fixed Cost	**43000**	-	**43.000**	**43.000**	**43.000**	**43.000**	**43.000**	**43.000**	**43.000**	**43.000**	**43.000**	**43.000**	**430.000**
Diverse	**0,000%**	-	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Operating			63	345	671	755	345	169	418	671	837	795	5.071
Inventory			**0**										
			67	**67**	**67**	**67**	**67**	**63**	**20**	**20**	**20**	**20**	479
Operating			**-4**	**278**	**604**	**688**	**278**	**106**	**398**	**651**	**817**	**775**	4.592
Interest		**13**	**80**	**80**	**72**	**64**	**56**	**48**	**40**	**32**	**24**	**16**	523
Profit before		-13	-84	199	532	624	223	58	358	619	793	759	4.069
Loss	**0**												
Taxfree	**0%**												

Taxable		**0**	**0**	**199**	**532**	**624**	**223**	**58**	**358**	**619**	**793**	**759**	4.166
Income Tax	**18%**	**0**	**0**	**36**	**96**	**112**	**40**	**10**	**64**	**111**	**143**	**137**	750
Net Worth	**0,00%**												
Profit after		**-13**	**-84**	**163**	**437**	**512**	**182**	**48**	**293**	**508**	**651**	**623**	3.319
Dividend	100%	**0**	**0**	**163**	**437**	**512**	**182**	**48**	**293**	**508**	**651**	**623**	3.416
Net		-13	-84	0	0	0	0	0	0	0	0	0	-97

Appendix III (d). Profitability model: Cash flow.

Year		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Cash Flow													
Operating Surplus	surplus	0	63	345	671	755	345	169	418	671	837	795	5.071
Debtor Changes			**16**	**71**	**81**	**21**	**-102**	**-44**	**62**	**63**	**42**	**-11**	199
Creditor Changes			**9**	**42**	**49**	**13**	**-61**	**-26**	**37**	**38**	**25**	**-6**	119
Cash Flow before Tax		0	57	317	639	747	386	187	393	646	821	799	4.991
Paid Taxes			**0**	**0**	**36**	**96**	**112**	**40**	**10**	**64**	**111**	**143**	613
Cash Flow after Tax		0	57	317	603	651	274	147	382	581	709	657	4.378
Interest		**13**	**80**	**80**	**72**	**64**	**56**	**48**	**40**	**32**	**24**	**16**	523
Repayment		**0**	**0**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	597

Net Cash Flow		-13	-23	171	465	521	152	33	276	483	619	574	3.258
Paid Dividend			**0**	**0**	**163**	**437**	**512**	**182**	**48**	**293**	**508**	**651**	2.793
Financing - Expenditure		**140**											140
Cash Movement		127	-23	171	302	84	-360	-150	228	190	111	-76	605

Appendix III (e). Profitability model: Balance sheet

Year		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
<u>Balance Sheet</u>												
Assets												
Cash Account	**0**	**127**	**104**	**275**	**577**	**661**	**301**	**152**	**380**	**570**	**681**	**605**
Debtors	**25%**	**0**	**16**	**86**	**168**	**189**	**86**	**42**	**104**	**168**	**209**	**199**
Stock(inventory)	0,0	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Current Assets		**127**	**120**	**361**	**745**	**850**	**388**	**194**	**484**	**738**	**890**	**803**
Fixed Assets(booked value)		**808**	**741**	**674**	**606**	**539**	**472**	**409**	**389**	**369**	**349**	**329**
Total Assets		935	860	1.035	1.351	1.389	860	603	873	1.106	1.239	1.132
Debts												
Dividend Payable		**0**	**0**	**163**	**437**	**512**	**182**	**48**	**293**	**508**	**651**	**623**
Taxes Payable		**0**	**0**	**36**	**96**	**112**	**40**	**10**	**64**	**111**	**143**	**137**
Creditors	**15%**	**0**	**9**	**52**	**101**	**113**	**52**	**25**	**63**	**101**	**126**	**119**
Next Year Repayment		**0**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**
Current Liabilities		**0**	**76**	**317**	**699**	**804**	**341**	**150**	**487**	**786**	**985**	**945**
Long Term Loans		**664**	**597**	**531**	**465**	**398**	**332**	**265**	**199**	**133**	**66**	**0**

Total Debt		**664**	**673**	**848**	**1.164**	**1.202**	**672**	**415**	**686**	**919**	**1.052**	**945**
Equity		**284**	**284**	**284**	**284**	**284**	**284**	**284**	**284**	**284**	**284**	**284**
Profit & Loss Balance	**0**	**-13**	**-97**	**-97**	**-97**	**-97**	**-97**	**-97**	**-97**	**-97**	**-97**	**-97**
Total Capital		**271**	**187**	**187**	**187**	**187**	**187**	**187**	**187**	**187**	**187**	**187**
Debts and Capital		935	860	1.035	1.351	1.389	860	603	873	1.106	1.239	1.132

Appendix III (f). Profitability model: Profitability measurements.

Year		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Profitability Measurements													
NPV and IRR of Total Cash Flow													
Cash Flow after Taxes		0	57	317	603	651	274	147	382	581	709	657	4.378
Loans		664											664
Equity		284											284
Total Cash Flow & Capital		-948	57	317	603	651	274	147	382	581	709	657	3.430
NPV Total	**10%**	-862	-815	-577	-165	239	394	469	648	894	1.168	1.398	
IRR Total						19%	24%	25%	28%	31%	33%	34%	

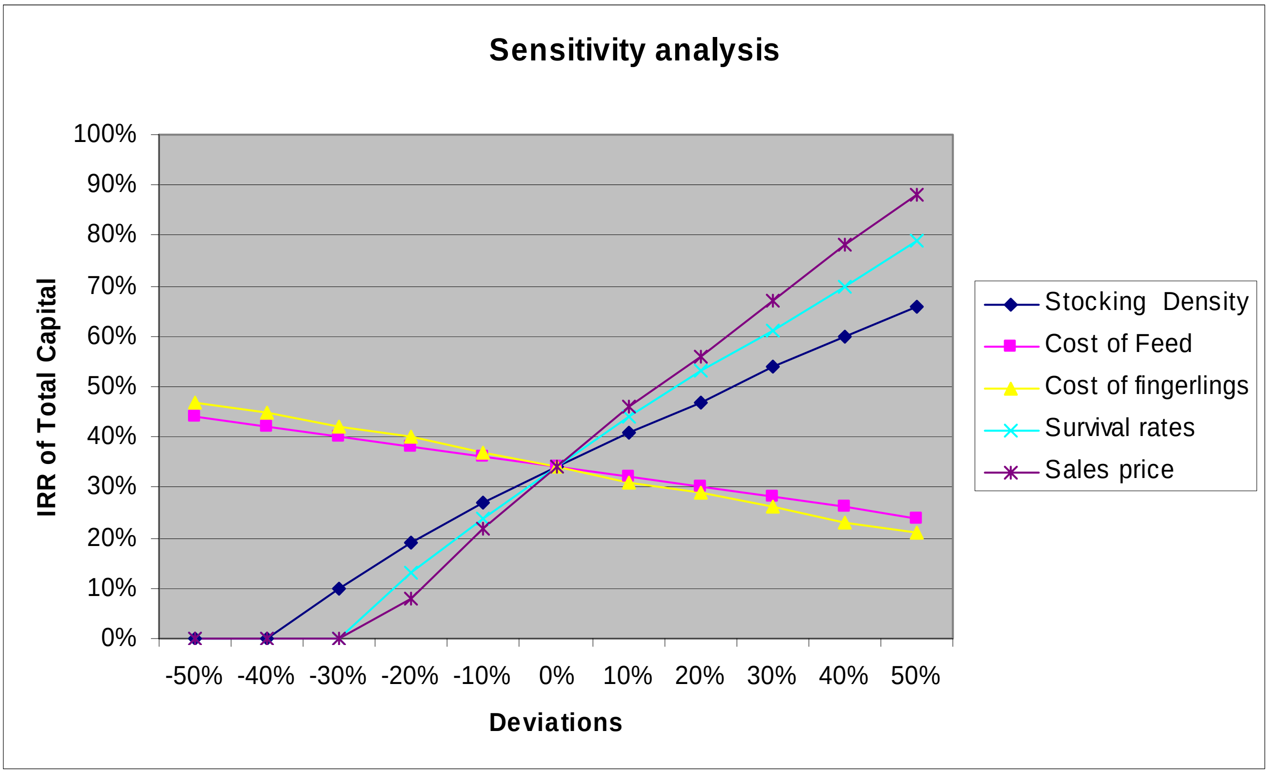
NPV and IRR of Net Cash Flow													
Net Cash		-13	-23	171	465	521	152	33	276	483	619	574	
Equity		284											
Net Cash Flow & Equity		-298	-23	171	465	521	152	33	276	483	619	574	
NPV Net Cash	**10%**	-271	-290	-161	157	480	566	583	711	916	1.155	1.356	
IRR Net Cash					30%	51%	54%	54%	56%	58%	59%	60%	

Appendix III (g). Profitability model: Sensitivity analysis (Table)

Deviations	Percentages	Stocking Density/m^2	IRR of Total Capital Stocking Density	Cost of Feed (Ksh)	IRR of Total Capital Cost of Feed	Cost of Fingerlings (Ksh)	IRR of Total Capital Cost of fingerlings	Survival Rates (Biomas) kg	IRR of Total Capital Survival rates	Sales Price (Ksh)	IRR of Total Capital Sales price
-50%	**50%**	**2,5**	**0%**	**6,9**	**44%**	**2,5**	**47%**	**442**	**0%**	**60**	**0%**
-40%	**60%**	**3**	**0%**	**8,3**	**42%**	**3**	**45%**	**530**	**0%**	**72**	**0%**
-30%	**70%**	**3,5**	**10%**	**9,7**	**40%**	**3,5**	**42%**	**619**	**0%**	**84**	**0%**
-20%	**80%**	**4**	**19%**	**11**	**38%**	**4**	**40%**	**707**	**13%**	**96**	**8%**
-10%	**90%**	**4,5**	**27%**	**12,4**	**36%**	**4,5**	**37%**	**796**	**24%**	**108**	**22%**
0%	100%	5	34%	13,8	34%	5	34%	884	34%	120	34%
10%	**110%**	**5,5**	**41%**	**15,2**	**32%**	**5,5**	**31%**	**972**	**44%**	**132**	**46%**
20%	**120%**	**6**	**47%**	**16,6**	**30%**	**6**	**29%**	**1.061**	**53%**	**144**	**56%**
30%	**130%**	**6,5**	**54%**	**17,9**	**28%**	**6,5**	**26%**	**1.149**	**61%**	**156**	**67%**
40%	**140%**	**7**	**60%**	**19,3**	**26%**	**7**	**23%**	**1.238**	**70%**	**168**	**78%**

50%	**150%**	**7,5**	**66%**	**20,7**	**24%**	**7,5**	**21%**	**1.326**	**79%**	**180**	**88%**

Appendix III (h). Profitability model: Sensitivity analysis (graph)



Fish Farming: Getting Started

What is Fish Farming?

Fish farming or aquaculture is the husbandry of aquatic organisms. It is the rearing and breeding of fish under controlled conditions. It involves raising fish in ponds, tanks or enclosures for food. Some examples of aquaculture include raising catfish and tilapia in freshwater ponds.

Why fish farming?

- ✓ **Food for the family (fish is a good source of proteins)**
- ✓ **Source of income**
- ✓ **Employment creation**

How to get started?

Before starting fish farming, a farmer needs to have basic knowledge on fish and fish farming in general. He/she then needs to have money (capital) to invest. The amount of money and kind of facilities required depends on the type of fish farming programme, such as food fish or fingerling production.

The investment may be described as land, buildings, ponds and startup costs (constructing ponds, digging water wells, constructing a farm house and store, installing pumps and pipe systems for water, digging drainage ditches, constructing access roads, etc).

Criteria for an optimal fish farming project:

- ✓ **Located on suitable site, suitable land and reliable water source**
- ✓ **Knowledge of the relevant land and climatic conditions**
- ✓ **Surrounded by supportive infrastructure**
- ✓ **Planned conservatively for cost-effective production, under local conditions**
- ✓ **Designed as a multipurpose production system**
- ✓ **Engineered and constructed to last**
- ✓ **Backed up technology**
- ✓ **Access to the relevant target markets**
- ✓ **Environmentally friendly enterprise**

Site Selection:

The success of a fish farming project largely depends on your project site conditions. Site conditions determine whether your fish farm will competitively produce. Correct selection of the site, correct design of your fish farm in this site, can 'make-or-break´ your new business.

Site selection process takes into account the biological traits of the target fish, the intended capacity that facilities required to achieve optimal and cost effective production.

Factors to consider:

- ✓ **Climate: Precipitation, temperature range, winds, solar radiation, cloudiness**
- ✓ **Water source: Type, availability, seasonal flow rate, elevations, flooding**
- ✓ **Water quality: Composition, salinity, mud erosion, etc**
- ✓ **Land: Topography and the elevation system of land and water source**
- ✓ **Soil: Profile and mechanical characteristics for construction**
- ✓ **Environment: Pollution, hazards, sensitive ecological niches**
- ✓ **Infrastructure: Roads, services, access, communication, electrical grid, etc**

- ✓ **Social: Neighbours**

What fish should I produce?

Criteria for selecting the appropriate fish to culture:

- ✓ **Full control over the life cycle processes in captivity**
- ✓ **Fast growth rate, from egg to market size**
- ✓ **Simple and inexpensive dietary needs**
- ✓ **Hardiness and resistance to disease**
- ✓ **Market acceptability**
- ✓ **Availability of proven technology**

Additional ´burning' questions:

- ✓ **How shall I choose the best possible site for my project?**
- ✓ **What is the best production system?**
- ✓ **What is the best possible crop organism to grow?**
- ✓ **How, and who, shall design my project?**
- ✓ **How much will I have to invest?**
- ✓ **What will be my operating costs?**
- ✓ **What will be my financial returns, and profitability?**
- ✓ **How shall I protect my investment in aquaculture over the years?**

What basic knowledge do I need to have on fish farming?

- ✓ **Biology of the fish to farm ("from egg to table size")**
- ✓ **Design and construction of production units (ponds)**
- ✓ **Required basic inputs (water and energy)**
- ✓ **Required basic materials (feeds, drugs and chemicals)**
- ✓ **Broodstock management**
- ✓ **Hatchery management/operations**
- ✓ **Nursery management**
- ✓ **Grow-out (pond ecology and water management, etc)**
- ✓ **Post harvest handling (processing)**
- ✓ **Book/record keeping**
- ✓ **Aquaculture and the environment (disease control, etc)**
- ✓ **Work force needed**
- ✓ **Marketing of aquaculture products**

Where to get initial (starting) capital?

- ✓ **Own funds (savings)**
- ✓ **Government support**
- ✓ **Loans from banks, financial institutions, Savings societies, etc**
- ✓ **NGOs support**

Who shall I contact for more information?

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Record Keeping and Profit Evaluation of Small Scale Fish Farming in Kenya

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1. INTRODUCTION

Most fish farmers in Kenya lack information on how to assess and determine the profitability of their farms. The consequences are that many fish farmers do not achieve good fish production in their ponds. Other ‘potential’ farmers avoid going into fish farming and other farmers become ‘inactive’ because the profitability of aquaculture has not been demonstrated to them.

It has also been observed that most aquaculture farmers do not keep records on their fish farming activities and if they do, then it is done in a haphazard manner. Yet, record keeping is one of the most fundamental and critical aspects of aquaculture, in evaluating the viability and profitability of any aquaculture enterprise.

There is therefore the need to formulate a basic tool (pamphlet) that farmers can use as a guide in keeping farm records and evaluating the profitability of their fish farms.

2. WHAT THIS GUIDE AIMS TO ACHIEVE

Assist farmers:

- **To keep farm records on operating expenses and incomes**
- **To be able to calculate net farm income from sales and operating costs**
- **To identify profit-maximizing levels of production**
- **To understand how to asses and interpret the viability and feasibility of aquaculture business.**

3. WHAT ARE THE KEY FACTORS TO CONSIDER IN STARTING A SUCCESSFUL CATFISH FARMING BUSINESS?

1. **Available market**
2. **Appropriate broodstock quality**
3. **Availability of good water quality**
4. **Availability of quality seed/fingerlings**
5. **Availability of quality feeds and prices**
6. **Financial support (credit and or loan facilities)**
7. **Consistent product inspection**
8. **Disease control and availability of therapeutics**

4. FARM RECORDS

4.1 FISH RECORD KEEPING AT THE FARM LEVEL

FARMERS´ NAME:
FARMERS´ ADDRESS:
STATUS OF TENURE:
FISH POND:
NO. OF PONDS:
AREA: M^2

DEPTH: METRES

FISH CULTURE SYSTEMS:
Extensive Semi-intensive Intensive
TYPE OF FISH CULTURE:
Monoculture Polyculture Integrated
POND MANAGEMENT
Pond Preparation:
Method of cleaning:
Date of cleaning:
Lime (Kgs used):
Inorganic manuring (Kgs used):
Urea:
DAP:
TSP:
Organic manuring (Kgs used):
Chicken/cow/pig manure

4.2 FISH STOCKING RECORD

Date	Species	Number	Average weight (g)	Total weight (Kg)	Price (Kshs)	
					Per indiv.	Total cost
Total						

4.3 MONTHLY FISH PRODUCTION MANAGEMENT RECORD

MONTH:_________________ YEAR: ____________________

Date	Labour			Fingerlings		Application of fertilizer and lime										Feeds								Fuel		Others	Daily Total (Ksh)
	Type of work	Hrs	Ksh	Kg	Ksh	Lime		Organic		Urea		DAP		TSP		Rice bran		Wheat bran		Fishmeal		Other feeds		Qty	Ksh	Ksh	
						Kg	Ksh	Kg	Ksh	Kg	Ksh	Kg	Ksh	Kg	Ksh	Kg	Ksh	Kg	Ksh	Kg	Ksh	Kg	Ksh				
1																											
2																											
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4.4 FISH SAMPLING RECORD

Date	Pond number	Fish species	Average weight (g)	Estimated		Estimated Biomass		Culture period(day)	Growth rate (g/day)
				Survival (%)	Number	Kg/pond	Kg/ha		

4.5 FISH HARVESTING RECORD

NAME OF FARMER:____
FARM NAME:____
POND N0.____________________ POND AREA: ______________ M^2

Date	Species	Number	Average weight (g)	Total weight (Kg)	Price		Remarks
					Ksh/Kg	Total (Kshs)	

5. ECONOMIC EVALUATION OF FISH FARM

5.1 PRODUCTION PERIOD YEAR:_______________

	A. Operating cost	**Kshs**
1	Pond cleaning	
2	Liming	
3	Fingerlings	
4	Fish feed	
5	Organic manure	
6	Inorganic fertilizer	
7	Labour	
8	Pond lease	
9	Chicken house	
10	Chicken cost	
11	Chicken feed	
12	Overheads	
13	Interest on operating capital	
	Total Operating Expenses	
	B. Returns	
1	Returns from sale of fish	
2	Returns from sale of eggs	
3	Returns from sale of chicken	
4	Value of fish consumed at home	
5	Value of fish given in kind at pond	
6	Other returns incidental to production	
	Total Sale Income	

C. Net Income (Kshs) = Total Sale Income – Total Operating Expenses

5.2 CALCULATING PERFORAMANCE INDICES OF A FISH FARM

1. **Net income = Total sale income – Total operating cost**
2. **Net income per ha of fish pond = Net income/size of farm (ha)**
3. **Net income per kg of produce = Net income/ Total Production (Kg)**
4. **Production costs of fish per kg = Total operating cost/Kg of fish produced**
5. **Production per ha/year = Total fish (kg) in a year/Area of farm (ha)**
6. **Percentage return on operating cost = (Net income/Total operating cost)x100**

Fish farmers should be encouraged to maintain proper records of their fish culture operations. The main befits from record keeping are that:-

a) **Such record will provide them with a means of evaluating their performance.**
b) **Properly kept records will pinpoint to the farmers the causes or factors responsible for their high profit levels or losses in each crop or year. Such information will provide them with a more reliable basis to make decision affecting their farm operations in the future.**
c) **These records can be shared by the government agencies formulating policies and developing programs for the development of fish culture in the country.**

6 FISH FARMING AS A BUSSINESS

Fish farming in Kenya is an outdoor activity due to the warm climate. Enterprise budgets are the basic tools to estimate general profit levels in aquaculture. It is important for farmers to note that catfish farming in Kenya can de developed into a highly technical industry comprised of (three) major areas.

6.1 Supplies and services

These are the inputs that farmers need to grow fish. Aquabusinesses can be set up to manufacture, distribute, and provide the supplies and services needed by fish farmers. Examples include feed, equipment, electricity, chemicals, fertilizers, motor vehicles operators, and consultant services. People can be employed in all these areas.

6.2 Production

This involves growing fish for a variety of markets. Production includes spawning, hatching, growing fry and fingerlings, and growing fish.

6.3 Marketing

This involves of all the activities in getting fish to the consumers in the desired form, such as processing, packaging, transporting, storing, and other functions.

Fish farming in Kenya has a potential to grow into a huge industry and create employment in supplies and services, farming and marketing. These are some of the key areas which farmers need to identify and invest in. For instance farmers can invest in feed mills, equipment manufacturing and processing.
It is important to note that investment in research, development, and education also plays a major role in the rapid growth of the catfish industry. Overall, the successful growth and development of the fish industry in Kenya will depend on the leadership provided by key farmers, business and industry officials, financial agencies and government programs to support expansion of the fish industry infrastructure.