PEPPERDINE UNIVERSITY

The Journal of Entrepreneurial Finance

Volume 18
Issue 2 *Summer 2016*

Article 3

February 2017

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Recommended Citation

Adanu, Kwami and Adanu, Mawufemor (2017) "Returns to Tilapia Fish Farming in Ghana – Implications for Tilapia Pooled Investment Vehicles," *The Journal of Entrepreneurial Finance*: Vol. 18: Iss. 2.
DOI: https://doi.org/10.57229/2373-1761.1301
Available at: https://digitalcommons.pepperdine.edu/jef/vol18/iss2/3

Returns to Tilapia Fish Farming in Ghana – Implications for Tilapia Pooled Investment Vehicles

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Abstract

In Ghana, the private sector's response to financing constraints associated with aquaculture investment has been to employ Pooled Investment Vehicles (PIVs). Unfortunately, several of these PIVs faced insolvency with huge losses to investors as returns promised investors turn out to be unrealizable. The premise of this study is that such insolvency problems occur mainly because of the lack of reliable data on likely returns and risk associated with Tilapia farm investments. This study improves on the "single value" profitability estimates of previous studies by performing Value at Risk (*VaR)* analyses on estimated farm-level returns, and 5,000 Monte Carlo simulation trials of the NPV to examine distribution of the long term returns to Tilapia farms. Results indicate that 99 percent of farms surveyed recorded positive net returns with an average return of 36 percent per cycle or 72 percent per annum. The VaR result suggests that there is a 5 percent chance that short-term returns in Tilapia farming would fall below 20 percent level per 6-month cycle. Further, 80 percent of the farms included in the study recorded positive NPV. The simulation produced Average NPV of 4026 Ghana cedis and IRR of 24 percent per cycle. This implies that offering more than 48 percent returns per annum to investors results in negative NPVs that lead to insolvency.

Keywords: Returns; Tilapia; Cage; Risk; Ghana

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1. Introduction

The fisheries sector of the Ghanaian economy is relatively small and characterized by a very erratic growth pattern. For 2014, the sector was estimated to contribute about 1.7 per cent of Gross Domestic Product (GDP) and 6.7 per cent of the GDP from the agricultural sector (Ghana Statistical Service, 2014). Evidently, contributions of the sector to both GDP from the agricultural sector, and overall GDP are minimal. There is however significant unexplored potential in the sector given that fish production in Ghana falls well below fish consumption levels. The Ghana Medium Term Agricultural Sector Investment Plan (METASIP) policy document placed the excess demand of fish products in Ghana as at 2007 at 460,000 metric tonnes (MOFA, 2010). Part of this deficit is covered through fish imports which in 2007 was estimated to be 212,945 Metric Tons and valued at US$262 million (MOFA, 2010).

To increase the contribution of the fisheries sector to GDP, the government established the Ghana National Aquaculture Development Plan (GNADP) in 2013. The plan, which is to be implemented within a five-year period (2013–2018), aims to increase aquaculture production from 27, 750 metric tonnes to 130, 000 metric tons while generating an estimated 220, 000 jobs across the value chain (MOFA, 2012). Successful expansion of the fisheries sector however depends on effective fund mobilization and investment in viable fish farm projects. In addition, the cultivation of fish must be biologically and technically feasible and the net returns, at least enough to compensate for risks (Asmah, 2008). An analysis of financial and economic aspects of the fishing sector is therefore crucial because it helps to appraise the viability of investment and efficiency of resource allocation to improve existing management practices, and identify areas in which research would have substantial potential payoffs (World Bank, 2004).

In Ghana, the private sector's response to the problem of limited resources to finance aquaculture investment has been to employ Pooled Investment Vehicles (PIVs). Several Tilapia farming companies emerged and invited people to make investment placements that were channeled into Tilapia production and the proceeds used to pay back the principal and interest of these investments. Unfortunately, several of these companies hyped the profitability of Tilapia farms and promised investors returns well above 80 percent per annum that were simply unsustainable (CitiNews, 2016, Myjoyonline, 2013). Consequently, some of these companies including *The U.S Group*, and *Safeway Tilapia* faced insolvency with huge losses to investors. The premise of this study is that such insolvency problems occur partly because of the lack of reliable data on likely returns on Tilapia farm investments. To shed light on this, data from 97 Tilapia farms in the Volta and Eastern regions of Ghana was collected and analyzed to estimate realistic cost returns to Tilapia farming in the study area. Results of this study also serve as indicator cost returns to Tilapia farming in Ghana as a whole.

Notable studies on returns to fish farming in Ghana are Asmah (2008) Cobbina (2010). These studies produced point estimates of a range of profitability measures including Net Present Value (NPV) and Internal Rate of Return (IRR). This study improves on the "single value" profitability estimates of previous studies by performing Value at Risk (*VaR)* analyses on the estimated farm-level returns, and 5,000 Monte Carlo simulations of the NPV to examining distribution of the long term returns to Tilapia farms. The *VaR* analyses provide prospective investors with information on the risk-return profile showing all possible outcomes that could result from investing in fish farming in Ghana. Risk analysis thus supports the investment decision-making process by providing information on the variance associated with the estimated investment return.

The additional information on variability of returns is critical to growth of fish farming since point estimates of NPV fail to communicate information on the level of market risk-exposure of the investment. Consequently, investors are unable to make a determination on whether they are comfortable with the risk level of the investment before they decide to invest. This is a particularly relevant issue for Ghana where managers of several Tilapia producing companies are facing criminal prosecutions for luring individuals and other companies to make investment placements in their companies for promised returns that were not realized. The likely situation is that such managers based their quoted returns on limited data or average returns data, oblivious of the importance of returns distributional issues. Based on the V*a*R analysis, the study suggests an objective approach to determining sustainable returns to PIVs in Ghana's Tilapia industry.

2. Empirical Literature

According to Cobbina (2010), *Tilapia niloticous* is the main species of fish cultured in Ghana; this represents 80 percent of aquaculture production. The Food and Agriculture Organization (2006) reported that globally, Tilapia is the second most significant group of cultivated fish after carps, and the most widely grown of any farmed fish. Tilapia has high growth rate, adapts to a broad range of environmental conditions, and has the capacity to grow and breed in captivity. Lastly, Tilapia has strong resistance to disease (El-Sayed, 2006). In addition to the above, Tilapia has attractive characteristics as a food fish; these include white flesh, mild taste and firm texture (Suresh, 2005).

The Ghanaian aquaculture sub-sector is largely made up of small-scale farmers who practice extensive or semi-intensive aquaculture in earthen ponds with average productivity of less than 2.5 Mt/ha/yr (Awity, 2005). However, in recent times, commercial production using cages are being undertaken intensively by sections of the population. These commercial initiatives have brought about an increase in production of farmed fish and provided employment.

Some farmers rely wholly on the natural productivity of the ponds to achieve their production while others use agricultural by-products. The use of manure is however considered to be the most cost-effective way to increase pond productivity (Mataka and Kang'ombe, 2007). The type of manure used determines the amount of phytoplankton and zooplankton made available in the water, as well as the benthic materials developed. Pond productivity is influenced differently depending on the type of manure used (Kang'ombe *et al.* 2006). Using the right amount of manure is considered important as inadequate fertilization may result in low yield whiles excessive application can result in significant deterioration in water quality (El-Sayed, 2006). On average, it takes five to seven months for Tilapia to reach maturity (Garciaa *et al.* 2014). The sizes of Tilapia at harvest range from 50g to about 400g with an average of 170g.

Farm management involves more than just taking care of the biological processes involved; it includes paying close attention to economic and financial measures of the farm business as well (Engle and Neira, 2005). Studies on the economics of aquaculture focus on the profitability of aquaculture ventures. Cobbina (2010) conducted a study to demonstrate the profitability of aquaculture in Ghana by performing cost-benefit analysis for investment in a 2000 square meter pond for a 10.5 year investment period. Profitability indicators such as NPV, IRR, Payback Period (PBP) and Benefit-Cost Ratios (BCR) were computed based on assumptions imposed on secondary data obtained from the Department of Fisheries in Ghana. The study proved that aquaculture in Ghana is feasible and profitable with a positive NPV, an IRR of 32 percent, a benefit-cost ratio of 1.18 and a payback period which is slightly longer than four years. Sensitivity analysis conducted showed that the cost of feed, survival rate, as well as farm gate price of fish are the main factors affecting profitability. The study further revealed that a major constraining factor on the development of commercial aquaculture is high start-up cost. Fixed cost constituted 68.1 percent of the start-up cost with variable cost accounting for the remaining 31.9 percent. Cost of feed accounted for the bulk (83.8 percent) of the variable cost.

Dzomeku (2012) also did a cost-benefit analysis for cage culture Tilapia production. The analysis considered a 6 month investment period for 4m x 4m cage culture Tilapia farm that can stock about 12,000 fingerlings. Cost of the cage construction was amortized over a ten year period, which is supposed to be the life span of the cage. The analysis revealed that an annual return of 46 percent is obtainable. With a bigger cage which has about 30,000 stocking rate and more efficient utilization of feed, Dzomeku (2012) estimated that an annual net return of between 60-80 percent is obtainable. Furthermore, the study concluded that cage culture method is more profitable than any other method of Tilapia farming. Cages have advantages over other rearing systems. These include, low capital costs, relatively simple management, better quality of fish, and use of existing water bodies (Beveridge, 2004). Cages can also be relocated if unfavourable weather or other environmental conditions occur (Pillay and Kutty, 2005).

A review of the literature suggests that returns on investment in the aquaculture industry generally tend to be positive. Ignoring environmental costs, Liu and Sumaila (2007) for instance obtained positive NPVs at small, medium, and large scales for open netcage salmon farms. Afero *et al* (2010) compared economic performance of tiger grouper and humpback grouper at different production scales. The economic analysis of humpback grouper revealed an IRR exceeding 300 percent and PBP less than 1 for all production scales. For tiger grouper, small scale production farms made large losses for both short-term and long-term projections. For medium scale and large scale farms, IRR of 88 percent and 157 percent respectively were obtained. In general, it was observed that improved profitability performance is associated with increasing production scale. However, uncertainties surrounding actual returns remains. For an aquaculture firm that is inviting investment placements from the public, it is critical to have good information on the distribution of returns in order to provide reliable investment returns quotes for investors, and determine tolerable interest rates on loan funds from the Bank.

3. Data

Data for this study was obtained from conducting surveys through the administration of questionnaires in 2013. In all, 97 farms were surveyed in the Eastern and Volta regions of Ghana. Questionnaires were carefully designed with cross-cutting verification questions to identify errors in farmer responses and provide opportunities for enumerators to probe for more accurate figures. The respondents were selected based on their availability and ability to provide the needed information. Two main farm-types were identified during the survey. These are cages and ponds / dugouts. About 99 percent of the 97 farms surveyed operated cage farms, with only 1 percent operating pond / dugout farms. About 19 percent of the 97 respondents owned the farms, 7 percent owned it jointly with others and 74 percent were caretakers. The farms visited were all located along the Volta Lake.

The study revealed that investment in fish farming in the study area is male dominated with 99 percent of the farms being owned by males. Seventy-three (73) percent of the farmers surveyed have been in business since 2010 and 25 percent since 2006. This finding is consistent with Asmah (2008), which noted that women accounted for less than 5 percent of fish production at the subsistence level. Most of the managers of fish farms are 26 to 35 years old. This shows that the youth are well represented in fish farming.

The educational background of respondents is categorized into seven groups. These are, none (no formal education), primary education, junior high school (JHS) education, middle school leaving certificate (MSLC), senior high school (SHS) or vocational / technical education, ordinary level (O' Level) education, and tertiary education. Twenty-three (23) percent of the respondents had no formal education, 19 percent had only primary education, 39 percent had JHS education, 4 percent had MSLC, 13 percent had SHS education and 3 percent had tertiary education. That 23 percent of the respondents have no formal education is a bit on the high side. The level of education of the fish farmer is generally thought to affect farmer knowledge level, skill development, exposure to production technology and marketing practices, and adoption of improved technology (Singh 2003).

4. Analytical Methods

The data analysis involves returns analysis to evaluate Tilapia farm profitability, and risk analysis of returns to examine why some Tilapia PIVs in Ghana may be having solvency problems. The total cost of production in a fish farming business is the sum of fixed costs and variable costs. Fixed costs include the cost of capital assets such as land and costs involved in pond construction. Variable costs on the other hand cover operational costs and depend directly on the scale of operations. Payments made for inputs such as labour, feed, fingerlings and transport all come under variable costs. The revenues in a fish farming business are the financial gains obtained from selling the fish at the end of each production cycle. It is assumed that the fixed assets,(that is the land and the pond), have no terminal value at the end of the 10-year estimation period.

The most common indicators that are normally used in capital budgeting to determine the financial desirability of an investment include NPV, PBP and IRR. Cobbina (2010) noted that the

NPV is the most desirable among the indicators when one has to choose among a range of feasible investment projects within the constraint of a limited investment budget. On the other hand, IRR can be highly sensitive to the project's time horizon and accruals of costs and revenues at different time periods and can therefore give conflicting results of profitability as compared to NPV.

The NPV is the present value of future cash flow, discounted at the appropriate cost of capital minus the initial amount invested (Shapiro 2005). Algebraically, NPV is represented as,

$$NPV = -Co + \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + \cdots \frac{C_t}{(1+r)^t} \quad (4)$$

Where $-Co$ is the initial investment, C_t is cash flow in cycle *t*, r the discount rate, while t refers to time in years. The larger the NPV is for a given investment level, the more viable the project. The advantages of using NPV when evaluating a project's profitability is that it allows for the comparison of different projects, irrespective of specific cash-flow schedules and economic life.

IRR is the discount rate that makes the present value of net cash inflow equal to zero (Shapiro 2005). Hence, a project evaluated according to IRR is acceptable if its IRR is greater than or equal to the required rate of return (Petty *et al.* 1996). It can also be calculated by solving for IRR in Equation (5):

$$0 = -Co + \frac{C1}{1+IRR} + \frac{C2}{(1+IRR)^2} + \cdots \frac{Ct}{(1+RR)^t} \quad (5)$$

Where $-Co$, C, r and t are the same as defined in Equation 4.

In addition to the NPV, PBP values are estimated for each farm. PBP is the length of time necessary to recoup the initial investment from net cash flow (Shapiro 2005). This is a common means of choosing among investments in a business enterprise, especially when the choice entails a high degree of risk (Gittinger 1982). Shorter payback periods are preferred to increase return and reduce risk (Larson *et al.* 2002).

Risk Analysis

Most projects face some uncertainty during the life time of the project. These uncertainties can affect the profitability of the project and thus affect decision making. Uncertainties may come in the form of variations in production inputs, changes in market prices and even output quantities. In making investment choices one may want to know the effect that these variations could have on returns of the investment.

There are several ways of analyzing the impact of variations in factors on the NPV. These include sensitivity analysis, break-even analysis, scenario analysis, V*a*R analysis and simulation studies. Sensitivity analysis is the assessment of the consequences of changing inputs and model parameters without considering the probability distributions of these changes. Sensitivity analysis is normally done one-factor-at-a-time. Changing one factor at a time makes it easy to interpret sensitivity analysis results. Scenario analysis recalculates the model for a combination of simultaneous changes in input variables. The scenarios are considered realistic futures. Normally, an optimistic and pessimistic scenario is considered besides the base scenario. The problem with sensitivity and scenario analyses are that the inputs are selected arbitrarily. In this study, we focus on VaR analysis of profits and Monte Carlo simulation of the NPV.

Risk analysis assesses the same effects as in sensitivity analysis but considers the probability distribution of these inputs as well. *VaR* is a uniform measure of risk used to measure returns on risk-adjusted basis. The project's economic risk is expressed as a probability distribution of a negative NPV exceeding a critical value, c. The idea is to find the riskiness of the NPV for a project. For a 5 percent *VaR*, the task is to find the quantile such that 5 percent of the distribution is on its left side. That is, at a given confidence level, c, we wish to find the worst possible realization, R* such that the probability of exceeding this value is c. Thus,

$$c = \int_{R^*}^{\infty} f(r)dr \qquad (6)$$

The probability of a value lower than R^* is thus 1-c and $f(r)$ is the probability distribution of the NPV (Jorion, 1996).

Next, a Monte Carlo simulation is performed to evaluate the impact of random variations in cash flows on the average NPVs generated. The Monte Carlo simulation is fundamentally not different from scenario analysis which is founded on the researchers' assumptions except that in Monte Carlo, the computer builds the scenarios. Here, the normal distribution is imposed on variations of the NPV. Equivalently, using a discount rate that allows for risk should produce a result in a deterministic analysis that is identical to the expected value of the probability distribution of NPVs generated using that discount rate. But with simulation, we have more insight into the risk/return profile.

5. Results

Cost-Return analysis was used to evaluate the financial performance of the 97 farms visited. A time horizon of 10 years (20 production cycles) was assumed for the purpose of this research. Analyses are done on per cage basis. Two types of analyses are carried out; one that looks at short term profitability of the business and another which looks at long term profitability. The short term analysis involves estimation and analysis of production costs, revenues and net revenues for a 6-month production cycle and on per cage basis. For farms operating multiple cages, cost and revenue figures are averaged across cages. The long term analysis on the other hand examined the performance of each farm over the 10-year period under consideration. This was done by employing discounted cash flows and simulation of the NPV under normal distribution.

For the short term profitability analysis, fixed cost per production cycle was determined by dividing total fixed cost of the project over a period of 10 years by 20 (production cycles in 10 years). This was added to the variable cost per production cycle to obtain total cost per production cycle. In general, fixed costs were estimated from the cost of land / space on the lake and cost of cage / pond construction amortized over 10 years. Cage construction has two main costs; cost of metal drums and metal pipes, and cost of nets and ropes. A life span of 10 years was assumed for the metal parts and 4 years for the nets and ropes based on local knowledge about how long these materials last. The variable costs considered in this study include; cost of fingerlings, feed, drugs, labour, transportation, energy (electricity or others), telephones calls, marketing and taxes. A list of equipment used by the farmers, their estimated useful life and mean prices is presented in Table 1. Depreciated equipment costs were determined using the straight line method (Jolly and Clonts, 1993).

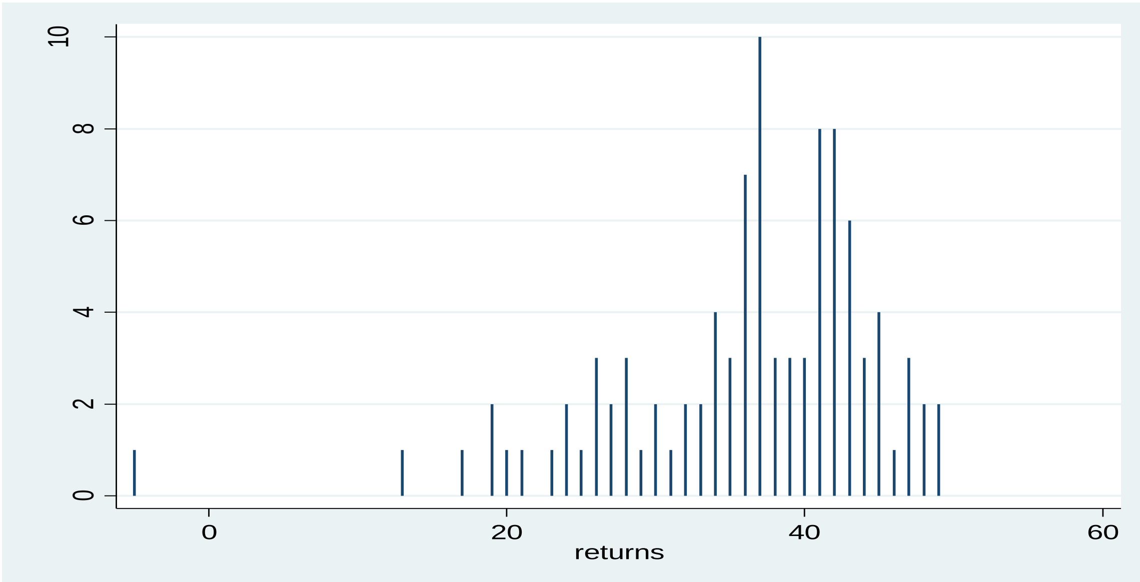
Table 1: List of equipment, annual depreciation rate, unit costs and salvage value

Equipment	Useful life (years)	Mean Price (GHS) Per Unit	Annual rate of depreciation (percent)
Empty barrels	10	48	10
Galvanized pipe	10	460	10
Anchor	10	500	10
Nets	4	4,181	25
Ropes	4	179	25

Revenue figures used for the analysis were extracted from the data provided by the farmers on sales made. Instead of asking farmers to report unit prices for Tilapia sold on their farms, farmers were asked to report the highest and lowest revenues made per cage in the past 12 months. Average revenue per cage was computed from the minimum and maximum revenue figures and the farmer asked to use the three estimates as price posts to come up with a final typical realizable revenue from a cage of Tilapia. This approach to estimating farmers' revenues from Tilapia sales increased the chances of obtaining reliable data since the farmers largely kept no records.

Out of the 97 farms sampled, 96 had positive net returns (profit) with only 1 (farm 37) making a loss. An average return (on cost) of 36 percent was obtained with the highest return being 49 percent and the lowest, -5 percent. A plot of average returns per cage from the 97 farms appears in figure 1 below.

Figure 1: Distribution of Short-Term Returns to Tilapia Farms



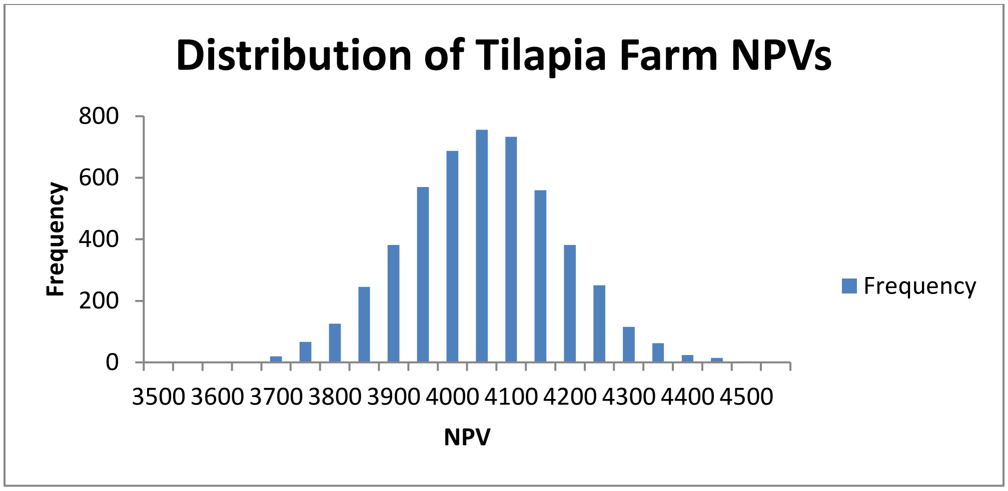
An analysis of the data collected for farm 37 was done to investigate the loss recorded for this farm. The analysis revealed that farm 37 had a mortality rate of 65 percent, which is relatively high.

To perform the long-term financial viability analyses, the cost and revenue data was used to create a cash-flow for each of the 20 production cycles over the 10 year period. It was assumed that the revenues and variable cost values in the first cycle will be same for all subsequent cycles. This is a rather strong assumption thus the study results should be interpreted with caution. Using the NPV method, a rate of return of 21.28 percent was used to discount the net revenue at the end of each cycle to present value. The rate of return of 21.28 percent is the annual interest payable on a 182 day treasury bill in Ghana as published by the Bank of Ghana for June 2014. For 6-month production cycles, this implies that each cycle should be discounted using a rate of 10.64 percent. The rate is however doubled here because the riskfree rate is rather inappropriate for discounting a project that is known to be risky. Using the risk free rate amounts to setting a standard which is below normal for the project.

The average NPV across all 97 farms is 1,654.52 Ghana cedis. This figure is associated with an average IRR of 24 percent and average payback period of 1.93 years. Out of the 97 farm samples, 78 had positive NPVs and 19 had negative NPVs. This means that approximately 80 percent of the farms were profitable in the long-term. The lowest payback period for the profitable farms was 0.40 years (0.80 production cycles) and the highest was 2.11 years (4.23 production cycles). The IRR for all the profitable farms were higher than the discount rate of 21.28 percent. The lowest IRR obtained was 21.48 percent and the highest was 125.87 percent.

For a sample size of 97 the 5 percent V*a*R returns can be found by finding the return such that the number of observations to its left is 0.05 x 97 = 5. This may be computed from Figure 1 or a ranked list of the returns. The V*a*R analysis yields a return of 20 percent on a cycle of Tilapia farming. The result suggests a 5 percent chance that returns in Tilapia farming would fall below 20 percent level. This result summarizes the downside risk over a cycle of Tilapia farming. Investors can decide if they are comfortable with the level of risk presented before investing.

A 5000 trial Monte Carlo simulation of the NPV is run with a standard deviation of 10 percent of the baseline NPV. The baseline NPV refers to the initial NPV computed per farm over the 10 year period. The simulation produced Average NPV of 4026 Ghana cedis and IRR of 24 percent per cycle. This implies that offering more than 48 percent returns per annum to investors results in negative NPVs that lead to insolvency.



6. Conclusions

The objective of this study is two folds: to determine if Tilapia farming ventures in Ghana are indeed as profitable as often claimed by Tilapia PIV managers, and to come up with an acceptable estimate of returns that Tilapia PIVs may offer investors and remain viable. This objective is accomplished by producing a range of short-term and long term profitability estimates. Results show that investment in Tilapia farming in Ghana is largely viable. The IRR is used as estimate of the maximum returns that PIVs could offer investors and remain viable. A maximum allowable return of 48 percent is obtained. This implies that offering more than 48 percent returns per annum to investors results in negative NPVs that lead to insolvency. V*a*R results obtained suggest that there is a 5 percent chance that returns in Tilapia farming fall below 20 percent level. In a country where lending rates hover around 30 percent, a 20 percent return although high is inadequate.

This study is premised on the assumption that the trigger for eventual collapse of these PIVs has always been client agitation about PIV's inability to honor payment for returns promised investors. This assumption is however a limitation for the study. This is because the causes of business failure often extend beyond financial constraints. Khelil (2016) provides a useful framework for business failure classification which can provide the foundation for classifying and understanding Tilapia PIV venture failures in Ghana. Making use of the Khelil (2016) framework requires detailed case studies into each Tilapia PIV venture failure.

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