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Economic Analysis of Small-Scale Aquaculture Enterprise in Ghana; a Case Study of Sunyani Municipality

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Authors' contributions

This work was carried out in collaboration among all authors. Author MAA designed the study, collected data, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author BA managed the analyses of the study and managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study analyses the economic performance and gender distribution of the small-scale aquaculture of Ghana using Net Present Value (NPV), Internal Rate of Return (IRR), Cash flow as well as gender distribution of the small-scale aquaculture of Ghana.
Study Design: This study is exploratory in its design. The study identified certain relationships and associations. Data was gathered from a sample drawn from a population. Questionnaire-based interview was designed and administered to the small scale fish farmers in the Sunyani metropolis. Both quantitative and qualitative research methods will be employed for the study. A case study method will also be used due to the fact that it has the benefit of permitting for an intensive collection of data required to fulfil the goals of the research
Place and Duration of Study: The study was conducted at the Sunyani Municipality in the Brong Ahafo Region of the Republic of Ghana between November 2017 and February 2018.
Methodology: The study randomly selected 20 farms out 40 farms and farmers interviewed using

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questionnaire. A 600 m2 pond was further selected as a model of the small-scale aquaculture and used to perform the economic analysis.
Results: The total start-up capital for a 600-meter square pond is estimated at $2693.15. Huge part, 56.9 percent, of the amount goes into fixed investment like pond construction, acquisition of land, and farm buildings. The economic analysis shows a viable industry with an estimated NPV of $605.4484 and IRR of 24.19 percent.
With gender, the study reveals a huge gap in man-woman distribution in the fish farming trade. Majority of the farms surveyed did not females, with the male having 77 against the female with 23%.
Conclusion: The study has found a viable aquaculture industry with high profitability that can improve the livelihood of fish farming households.

Keywords: Small-scale; investment cost; operational cost; aquaculture; profitability; gender.

ABBREVIATIONS

NPV : Net Present Value
IRR : Internal Rate of Returns

1. INTRODUCTION

Fish is a major component of the human diet. Fish account for up to 20% of the average per-capita intake of animal protein [1]. The usage of fish has increased dramatically due to improved technology, which showcases powerful engines and sonar equipment and led to over fishing, causing a worldwide decrease in wild stock accounting for the decline in the fish population dynamics [2]. There is therefore an argent need to increase fish production by fish farming.

Aquaculture can be seen as an aspect of agricultural practices, mainly to increase the production of food above the level that was produced naturally. Today, aquaculture is responsible for an ever-increasing share of global aquatic food production, and accounted for 65% of the increase in fish production in the period 2005–2014. [3].

The fisheries resources of Ghana supply 45% of natural animal protein to the people. [4]. Most fish farmers in Ghana use earthen ponds and rely on natural productivity to feed fish, while others supplement feed with agricultural by-products [5]. The most cultivated species in the country is *Oreochromis niloticus* (Nile tilapia). Generally, due to health complications associated with consumption of meat, the consumption of aquaculture products is on the increase [6,3]. Moreover, Aquaculture is one of the fastest growing animal foods producing sectors offering employment and food security to the ever-increasing human populace in Ghana [7]. Furthermore, fish have been found to have self-life which is readily enhanced through low-cost sustainable technologies such as smoking, drying and salting [8,9]. On the other hand, fish is good in terms of gross body weight gain and protein gain per unit of feed intake [10].

Fish farming in Ghana is a profitable venture and it is rapidly expanding and it will continue to be profitable if the planning and management are well taken care of. Fish farming is geared towards the improvement of nutritional standards of the people and to create self- employment opportunities for Ghanaian communities. Secondly, fish farming has become more appropriate to developing countries because of the opportunities for waste recycling and integration with crops and animal farming [11].

Before starting any activity all likely costs involved in that activity should be taken into consideration. With aquaculture it is important that important technical factors such as water availability throughout the year, quality of water, availability of raw material (fingerlings, feed, etc.) and size of likely market must be taken into consideration as well as the cost and supply of labor and the selling price of the final product.

The purpose of every business venture is to generate profits. An enterprise budget is used to examine whether any business is profitable or not. If the total farm revenues from sales generated for the period are greater than the costs, it means profits are generated for that given period [12].

Further studies on aquaculture viability in Sunyani municipality are needed in order to improve the standard of living for people in the area and to help farmers in executing a successful trade. It is an expectation that

development of a knowledge base to help the small-scale fish farmers to better understand their business in order to make a significant profit will take place in a short while. This research will contribute to literature and serve as a platform to build upon for future studies. It will also aid small scale fish farmers to know more about aquaculture to improve their economic standards.

2. MATERIALS AND METHODS

2.1 Study Site

Sunyani is a city in the West African republic of Ghana, and is the capital of the Brong-Ahafo Region. The Municipality covers a total area of 29.3 square kilometers. One third of the total land area is not inhabited or cultivated which provides arable lands for future investment. The Municipality as selected because it has majority of fish farms in the region. Nearly one-half of the region's annual aquaculture production in 2010 was from the Sunyani Municipality. The study area and farms visited are presented Fig. 1 .

2.2 Sampling

Random sampling was adopted in this study. Simple random sampling technique was employed to select farmers for administering questionnaire. Farm list of the study site was obtained from the Fisheries Commission, and farms assigned with numbers from 1-40. Twenty farmers were interviewed. For profitability analysis 600 m2 pond was used as the basis for analysis because this is the average size used by most fish farmers in the municipality.

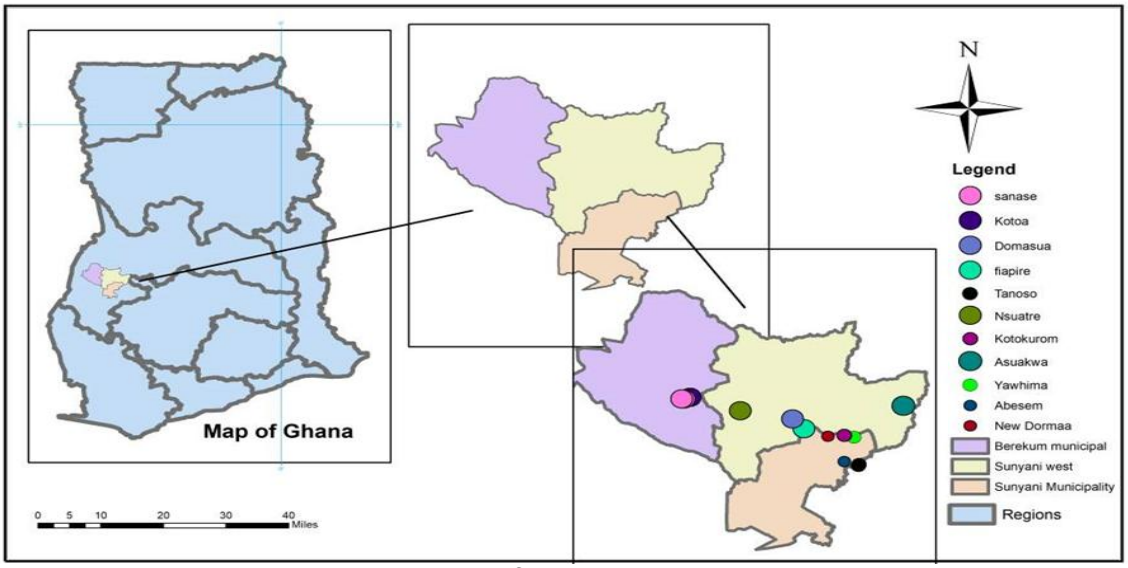
2.3 Data Analysis

Data collected was entered into Microsoft Excel (version 2016) and analyzed using the descriptive statistic feature to generate tables. Economic analysis was done by using calculating Net Present Value, Internal Rate of Return, Present Value, Net Profit, and production cost, value of harvested stock and market price per unit weight in kilogram using Ms. Excel formulas. Results are presented in tables and bar charts. Gender distribution data was coded and entered, and the percentage of occurrence calculated and chatted with pie chat.

3. RESULTS AND DISCUSSION

3.1 Investment Cost

In the present case study, the building costs were divided into pond construction, fencing and house constructing. The total value of buildings in the present case study, including contingency, was estimated to be about $1533.77. Regarding equipment needed in the operation such as a pump, vehicle, containers, refrigerator, scales and others, the total value was calculated as $ 1070.487. The value for other investment costs incurred was about $ 88.89. The total investment in the farm was $ 2693.15.



Map of study area

Table 1. Estimation of investment cost

Investment cost (DOLLARS)					
Equipment	**Quantity**	**Cost ($)**	**Building($)**		
Pump	1	200	**Item**	**Quantity**	**Cost**
Net	1	266.66	Pond	1	400
Container	2	88.89	Fence		0
Refrigerator	1	422.2	House	1	1111.11
PVC pipes	4	11.11	Sub-total		1511.11
Wheel barrow	2	31.11	Contingency	1.50%	22.67
Hoes		0	**Total**	**1533.77**	
Cutlass	2	7.78			
Scale	2	16.67			
Test kit		0	Others	Quantity	Value($)
Shovel	2	10.22	land		88.89
Sub-total		1054.67	Water		0
Contingency	1.50%	15.82	Total	88.89	
Total		**1070.487**	**Total investment**	**2693.15**	

**Estimation of investment cost for a 600m^2 pond **

Investment cost, coupled with subsequent cash flows, is an essential element to determining the value of a project. This study modelled the establishment and operation of 600 m2 fish pond using fish farmers' information as a base data. Investment cost in this study refers to the cost of building, equipment and other investments.

In the case study the total value of buildings in the present case study, including contingency, was estimated to be about $1533.77. Regarding equipment needed in the operation such as a pump, vehicle, containers, refrigerator, scales and others, the total value was calculated as $1070.487. The value for other investment costs obtained was $88.89. The total investment in the farm was $2693.15. Out of the start-up cost more than half (56.1%) goes into the fixed cost which involves the cost of land, pond construction and buildings. This shows that high level of investment capital needed as start-up in an aquaculture business usually stems from the high level of the fixed costs. This is in line with [13] findings where she found that, the high level of investment capital needed as start-up in an aquaculture business usually stems from the high level of the fixed investment costs.

The study shows that like many business investments, aquaculture is a highly capital-intensive business.

The aquaculture enterprise is capital intensive, characterized with high cost start-up and small-scale fish farmers may require access to funds [14]. Such huge investment cost affects small-scale aquaculture through perceivably low initial returns. This is inconsistent to the findings of [15] who investigated on the constraints of cage culture in Ghana, in which lack of access to funds had the highest mean rankings among the challenges presented. According to Nunoo; [16], small-scale fish farmers lack capital to expand and thus, their low investment costs have resulted in low profitability. Farm investment analysis, in contrast, is undertaken to determine the attractiveness of a proposed investment to farmers and to other participants, including the society as a whole.

3.2 Operating Cost

Cost of Operation were classified as variable and fixed costs (Table 2). Variable costs include cost of fingerlings, feed, fertilizer, transportation, weeding, machine repairs, erosion checks, harvesting cost, and electricity. The fixed costs considered include the payment of salary, because employees are permanent in the farm.

Operating cost refers to the cost incurred after farm establishment (equipment and building) for the production of farm produce. The operating cost is made of two cost components; variable cost and fixed cost. Yearly fixed cost component includes security and salary. The total value of fixed cost is estimated to be $186.67 per production cycle. These components remain fixed throughout the production period. Variable cost components are composed of items which market prices can change during the production period. These include feed, fingerlings, weed control, repairs, harvesting costs, and erosion.

Table 2. Estimation of operating cost

Cash out flows: cost of operating farm/cycle					
Variable items	**Quantity**	**Cost ($)**	**Fixed items**	**Quantity**	**Cost/cycle ($)**
Fingerlings	2400	106.07	Employee	1	133.33
Feed	24 bags	362.67	Security	1	53.3
Transport		111.11	**Total**	**$ 186.67**	
Weeding	1	8.89			
Erosion check	1	6.67			
Machine repair	1	5.56			
Electricity		11.11			
Harvesting cost	5	22.22			
Miscellaneous		2.2			
Total	**$ 637.11**		**Total out flow**	**$ 823.78**	

**Estimation of operating cost for a 600m^2 pond **

The variable costs constituted 55.2% compared to the total start-up cost and this is very close to the range of 33.5% to 55% obtained by [17] for commercial operators in the country. This rate, compared to what was obtained by [17], is also not surprising looking at the current steps taken to reduce the operational costs in the form of availability of inputs such as fingerlings at reduced or subsidized cost. It is however very important to note that the variable costs can vary depending on the scale and the level of production that one wants to engage in. Feed is an essential commodity needed in aquaculture operations and the efficiency with which it is utilized for growth depends on its quality and its utilization. In Ghana good quality feed is a major constraint faced by many operators. Since the country has very few producers (example Rannan West Africa Company Limited), majority of the feed used in the country is imported from countries such as Brazil, Netherlands and Israel, resulting in the high cost of feed as seen in this study .The main reason for pond abandonment in the Sunyani Municipality is high cost of feed[7]. This is also consistent to [18] and [19] who suggested that high cost of commercial feed is a major constraint to aquaculture in Ghana. In order to obtain bigger sizes of fish, good quality feed with a high feed conversion ratio is needed. Good quality feed may cost more than what was assumed in this study. Increasing the cost of feed by 30% and above will lead to the enterprise making losses. According to [19], availability quality and affordable fish feed will speed the development of the Ghanaian aquaculture sector.

3.3 Estimation of Profitability

3.3.1 Net Present Value (NPV) and Internal Rate of Return (IRR)

In Table 3, the net Cash Flow (CF) at year 0 is negative with a negative PV. This because an initial investment (cash outflow) and a zero (0) production (no cash inflow). The PVs are positive for the net cash flows for year 1, 2, 3, 4, and 5. The NPV obtained at a DR of 15% capital is $ 605.4484. This implies that the fish farming enterprise is highly profitable even at a Minimum Attractive Rate of Return (MARR).

Table 3. Computation of NPV and IRR

Year (t)	**Net CF**	**PV**	**DR (K)=** 15%*	**(1+K)^t**	**NPV** $\sum_{t=0}^{n} \frac{CF_t}{(1+k)^t}$
0	-12119.19	-12119.19		1	
1	4466	3883.4783		1.15	
2	4466	3376.9376		1.3225	
3	4356	2864.1407		1.520875	
4	4466	2553.449995		1.749006	
5	4356	2165.701859		2.011357	
Total	**9990.81**	**2, 724.52**		**(1+K)^t**	
	IRR= 24.18503%				**NPV = 2,724.518**

Note: 15 is the Minimum Attractive Rate of Return (MARR), interest rate with minimum profit to the investor*

DR(K): Discount rate : the interest rate used to discount a stream of future cash flows to their present value

General formula for calculating NPV

$$\sum_{t=0}^{n} \frac{CF_t}{(1+k)^t}$$

3.3.2 Net cash flow and present value

The results from Fig. 2 indicate a negative net cash flow and present value at year zero (0). This is attributable to the initial investment and in part, a zero production in the setup year (0). Observably, both the net cash flow and present value are both positive in the subsequent years. The net cash flows comparable appear stable whilst present value decline along the years as indicated in Fig. 2.

Increasing profitability is one of the most important drivers of business managers who continually look for ways to change the business to attain this objective [20]. Profitability is the primary goal of all business ventures. Without profit, the business will not survive in the long-run. So, measuring current and past profitability and projecting future profitability is very important [21]. The profitability was developed based on the results of the 600 m2 pond production model. Performance indicators used to assess profitability include gross revenue, net revenue, total investment, average price, net cash flows, net present value, and internal rate of returns.

The study found that, investing in aquaculture business in Ghana is a profitable venture and feasible. The NPV was determined using the minimum rate of return (MARR) as a discount rate (DR). Net Present Value (NPV) is a financial function that is calculated for an investment, and it represents the present value of an investment minus the amount of money it cost to buy-in. NPV realistically predicts future cash flows by discounting future cash flows using the projects appropriate discount rate (DR), called opportunity cost. Simply put, NPV is equal to “Present Value (PV) of cash inflows” minus “Present Value of cash outflows”. It can be seen in Table 3, the net Cash Flow (CF) at year 0 is negative with a negative PV. This because an initial investment (cash outflow) and a zero (0) production (no cash inflow). The PVs are positive for the net cash flows for year 1, 2, 3, 4, and 5. The NPV obtained at a DR of 15% capital is $605.4484. This implies that the fish farming enterprise is highly profitable even at a Minimum Attractive Rate of Return (MARR). The calculated NPV and IRR values are much higher than zero which indicates that the investment is potentially highly profitable, that is given that the assumptions which the estimates were based on are fairly accurate. The payback period of 5 years obtained in this study is within the10-year period considered for this operation as well as four to five years recommended by [13] for commercial operations in aquaculture to payback after investment. This is however not surprising looking at the short production cycle (7 month) for tilapia as compared to other species such as salmon culture with production cycle of more than a year. Most investors find projects with short payback periods more economically attractive, especially in markets that are lacking in credit facilities. An aquaculture business which takes 10 or more years to payback the cost of investment is considered to be unprofitable [22]. Hence this could serve as an encouragement to investors who normally would prefer a short-term investment as a measure of reducing risk. Risk is time related in the sense that the longer it takes for an investment to recoup its cost of investment, the greater the risk of failure.

Profitability is largely affected by the price at which the fish is sold. The government’s policy to ban imports of farmed fish aims at enabling local fish farmers to get better prices and increase their profit margin at the cost of the domestic consumers and foreign producers. Price however is also strongly dependent on the size of fish. This is where good fish production technology is essential. [23] goes so far as to imply that the ability of a Ghanaian producer to produce bigger sizes of fish allows him to set the price of his production as opposed the price-taking behavior of those who can only produce smaller sizes of fish. Thus, to be able to produce bigger sizes of fish is an advantage for the producer.

3.5 Gender

Gender distribution in the fish farming enterprise indicates the level of engagement of women and men. Women have played and still playing essential roles in the development of the fish farming subsector. On the other hand, aquaculture presents a development strategy for poor and busy women to combine household chores with farm operations. This present study reveals a huge gap in man-woman distribution in the fish farming trade. It is evident that males

dominate the fish farming business in Ghana. With the male having a percentage of 77 against the female with 23%. Majority of the farms surveyed did not females as shown in Fig. 3.

Gender distribution in the fish farming enterprise indicates the level of engagement of women and men. Enabling women to fully engage in and benefit from aquaculture and fisheries can boost production reduce poverty and enhance nutrition security for millions of fish-dependent households Women have played and still playing essential roles in the development of the fish farming subsector. This present study reveals a huge gap in man-woman distribution in the fish farming trade. It is evident that males dominate the fish farming business in Ghana.

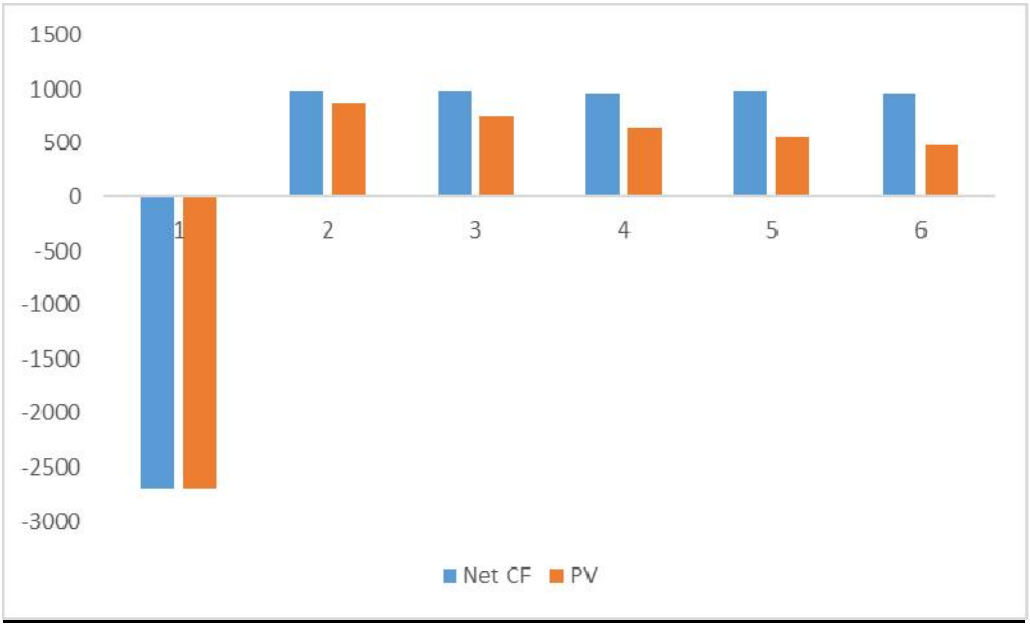


Fig. 2. A graph of net CF and net PV

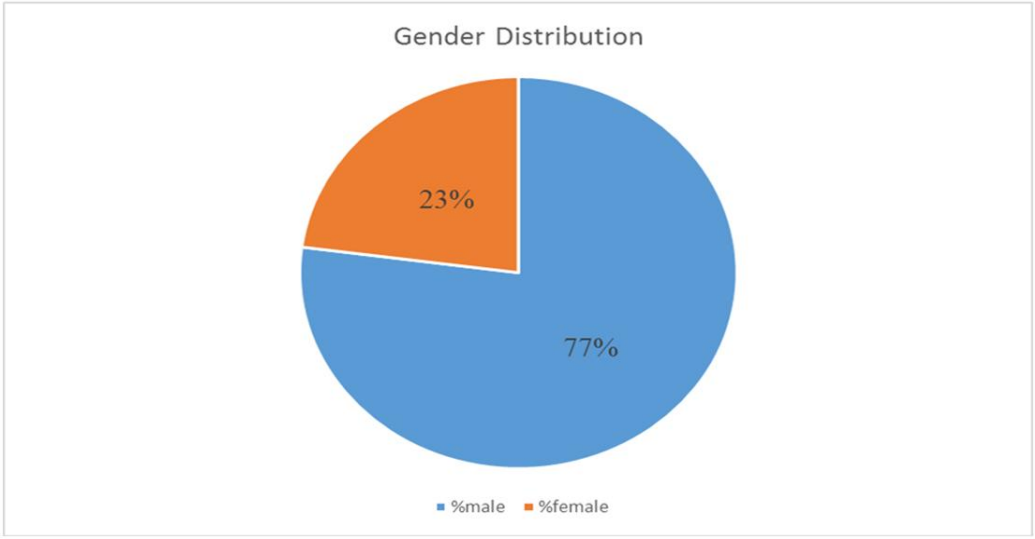


Fig. 3. Gender distribution

The findings in this study in in agreement with research works conducted. Aquaculture is therefore principally male-oriented particularly in relation to pond preparation, input procurement (fingerlings, fertilizer and feeds) and application of fertilizer and harvesting [16]. [17] attributed the low number of female ownership of farms to the fact that traditionally men are deemed to be the heads of the household unit in Ghana and farms owned and run by a family are likely to be in the name of the head of the family. Also, the involvement of women in subsistence fish farming activities also remains relatively unchanged and limited to feeding, processing of harvested fish and marketing.

Upcoming evidence reveals that gender equality will play a key role in these sectors' important contributions to achieving the Sustainable Development Goals (SDGs) on poverty reduction and food and nutrition security. In particular, gender equality in fisheries and aquaculture can bring many potential benefits including higher fish productivity and household incomes, as well as positive nutritional outcomes [24].

To summarize, the discussion above demonstrates that aquaculture in Ghana has a great potential to be highly profitable at the commercial level, depending on the scale of production as well as the size of the fish and the price at which the producer is able to sell the fish at the farm gate. Increasing the scale of production could mean moving from producing on a subsistence basis to a commercial basis by increasing the factors of production such as feed, fingerlings, labor, etc. By increasing the factors of production, the producer however will incur more costs, in absolute terms, than otherwise. If the production exhibits positive returns to scale, the average cost per production unit will however be lower than before. Finally, fish farming in Ghana is male dominated and need more female participation.

4. CONCLUSION

In Ghana, aquaculture is a highly profitable venture, depending on the scale of production as well as the size of the fish and the price at which the producer is able to sell the fish at the farm gate. In Ghana, aquaculture is a viable industry with high investment gains. Increasing the scale of production will involve from producing on a subsistence basis to a commercial basis by increasing the factors of production such as feed, fingerlings, labor, etc. The payback period for fish farming is 5 years. Finally, fishing in Ghana is male dominated and with less female participation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

UNIVERSITY OF ENERGY AND NATURAL RESOURCES, SUNYANI
DEPARTMENT OF FISHERIES AND WATER RESOURCES

Dear respondent this questionnaire is designed to be used for academic research on the **"THE ECONOMIC ANALYSIS OF SMALL-SCALE AQUACULTURE ENTERPERISE IN SUNYANI MUNICIPALITY"** The respondent is assured that all information provided was treated as confidential.

Part I: Personal Characteristics of Respondents

1. Sex: Male [ ] Female [ ]
2. Age:
3. Number of years of doing aquaculture business ?
   1 year and less [ ] 2 – 4 years [ ] 5 - 7 years [ ] Above 7 years [ ]
4. Highest academic achievements
   Primary [ ] Secondary [ ] 1st Degree [ ] Master's Degree [ ] other (specify)
5. Primary Occupation:……,
   Sec. Occupation:…….

Part II: Estimation of Investment cost

Equipment

Item	Quantity	Cost GH¢)
Pump		
Net		
Vehicle		
Container		
Refrigerator		
PVC Pipes		
Wheel barrow		
Hoes		
Cutlass		
Scale		
Test kit		
Shovel		
Sub total		
Contingency		
Total cost		

Building

Item	Quantity	Cost(GH¢)
Pond		
Fence		
House		
Sub total		
Contingency		
Total cost		

Other Investments

Item	Quantity	Cost (GH¢)

Part II: Cash flow

Cash Received from Farm Operations

Fish sold (Kg) per cycle	Value (GH¢)

1. Do you receive income from other farm activities? YES/NO
2. If yes how much? GH¢

Cash Paid for Farm Operating Expenses Per Cycle

Item	Quantity	Amount (GH¢)
Fingerlings		
Feed		
Water quality & availability		
Cost of fuel & transportation		
Labour		
Repair and maintenance		
Management		
Miscellaneous		

Cash Received From Sales

Item	Quantity	Amount (GH¢)
Brood stock		
Fingerlings		
Equipment		
Real estate		

Cash Flow From Financial Activities

Operating Loan Received

1. Did you receive any loan for the business? YES/NO
2. If yes, how much? GH¢…….
3. How much of the Loan have you paid? GH¢…….
4. Source of Loan? ……
5. Where you able to pay all operational cost? YES/ NO
6. If no how much did you pay? GH¢……..

Cash Received From Non Farm Activities

1. Did you receive any non farm income for the business? YES/NO
2. If yes, how much? GH¢…….
3. Did you pay for any non farm expenses? YES/ NO
4. If yes, how much?GH¢……

5. Did you make any withdrawals for family and living activities? YES/NO
6. If yes, how much? GH¢……..

Part II: Gender

1. How many employees do you have? ……
2. Are there males? YES / NO
3. If yes how many males?.....
4. Which activity are the males mostly associated with? …….
5. Are there females ? YES/NO
6. If yes how many females?.....
7. Which activity are the females mostly associated with? …….
8. Are range of employees.

Peer-review history:
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